THE TRIUMPH OF LIFE

By WILHELM BÖLSCHE

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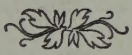

TRANSLATED BY

MAY WOOD SIMONS

CHICAGO
CHARLES H. KERR AND COMPANY
1917

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PREFACE

At the beginning of this little work it should be noted that it was originally the basis of a series of discourses delivered in the course of several evenings in the winter of 1903-4 at the Institute of Popular Natural Science in Berlin, the Urania (a creation of the gifted M. Wilhelm Meyer), and accompanied on the stage with decorative pictures and illustrations. The rich stage settings that were executed in the most effective and artistic manner, according to my suggestions by the well known and excellent artists of the Urania, Kranz & Harder, and that were the objects of warm general approbation, must naturally have strengthened the interest and made the text proper appear as explanatory of the visible picture and which without these pictures could not have been presented. Nevertheless, the wish has often been expressed to me, that the text might be printed. I have attempted to preserve the greater part of the composition, but all that was difficult to work out well in print, all that could by any possibility not be clear without the help of the illustrations, but that might appear fantastic, I have simply thrown overboard and put it into more suitable form.

The first part has remained essentially as it was, whereas of the second, which was illustrated on the stage by Harder's wonderful panorama and which no words could translate, only a part has been used. At any rate the thought has been more strongly expressed. The text is fragmentary,—not because it is made up of fragments of a lecture, but because a lecture of two hours or a pamphlet on such a theme necessarily can be no more than a fragment.

The individual mosaic stones are now in fact fitted into a whole, the whole is perfectly comprehensible without illustrations. Concerning certain topics (the deep sea, the prehistoric cave pictures) who ever wishes to go further will find more exact accounts (also in popular form but somewhat more rigid) in my books "Aus der Schneegrube," "Weltblick" and "Von Sonnen und Sonnenstäubchen." Those interested in heredity and memory are referred to a passage in a lecture of the recently issued and extraordinarily significant book by Richard Semon on "Die Mneme als erhaltendes Prinzip im Wechsel des organischen Geschehens zurückführen."

Friedrichshagen, April, 1905.

Translator's Note. The illustrations in the volume have been supplied by the translator from various sources, principally from Haeckel's "Kunstformen der Nature."

THE TRIUMPH OF LIFE

It was on that ever memorable night before the discovery of America. Sleepless, it is said, Columbus stood on board his ship and gazed out into the darkness. Lay there before him in this impenetrable blackness only the desolate ocean through which he had already sailed so long, or did there lie therein a new unknown land? Suddenly a light appeared moving mysteriously. It was a firebrand swung by an Indian. Under the veil of night there lay in fact, although yet unseen, the island of San Salvador, the first shores of the new world. In the morning, the cannons would salute, the palms would wave and it would stand revealed. In the night all concealed itself in this little red spark, this tiny star. We can picture to ourselves how in this ghostly hour the whole gigantic continent of America lay pressed together in this red star on San Salvador,—its snow-decked volcanoes, its enormous streams, its wild untrodden primeval forests, its endless green plains,—all unlocked in a moment to the searching eye of European culture in that tiny star-like point of light.

Yet what were the awe of this moment compared to another immeasurably more sublime! Indeed, only our imagination can conceive it. Let us imagine that there sounded through space the magic words, "Vanish, you dark arch above," and that before us there suddenly flamed the boundless starry heavens with its myriads of silver worlds. Imagine that it were given to us to pass through this icy world space as the ship of Columbus steered over the barren ocean,—and that before us appeared for the first time, also after an endless journey, the whole earth,—as a star,—this whole colossal globe with all its snowy mountains and blue oceans, with its green woodlands and yellow deserts, with the white ice fields of its poles around which quiver the red crown of the northern and southern lights—all comprehended in a single point of still, soft, white star-light like beautiful Venus, the old so-called star of love—a star among stars.

This is one of the most sublime pictures of which the mind of man can dream. All around are processions of other stars. A system that surpasses all of our accepted ideas of space extends through the boundless heavens: the whole fixed star system to which almost all of yonder stars belong. Probably this system takes in general the form of a spiral, a nebulous spiral composed of numerous isolated suns. When we

look at our strange cleft milky way we are looking into the yawning spiral windings of this cosmic architectural plan. Near the middle of the broad spiral floats our own sun as a small fixed star, constantly moving on with the progress of the whole. The sun moves toward the constellation of Hercules* with a speed of not less than eighteen and a half miles per second. Following the sun and in a certain relation to it are small bodies, splinters, mere individual stones in the spiral structure. Among them is the earth. Between star and star is endless space, boundless are the black depths, millions of miles between sun and planet, billions between sun and sun. We grow dizzy and seek a point of support for our phantasy. In imagination we climb on one of the meteoric iron blocks, that finest falling dust of the world structure which constantly whirls through the space between all suns and planets occasionally plunging down to us in the form of meteor stones. Rushing faster than the swiftest cannon ball this metal block has already left the glowing furnace crater of the sun lying to one side and plunges into the planetary space. Now it shoots suddenly with increased momentum toward an especially clear white planet that looks

*It is within this constellation that the point toward which the sun with its accompanying system of planets is traveling at present is situated.—Trans.

like a blossom against the black back-ground. It is the earth. The flower lies as though in a dark bud. It is the night side,—this beautiful star blossom does not shine of itself but is radiant only where the kiss of the distant sun is swept to it over millions of miles of space. A tiny point near it, the moon, drinks in the same light.

As we draw near the phases of this light move mysteriously, advancing here, receding there. The earth also follows the great law that vibrates through all the star world, it moves. It rolls itself rapidly on its axis. Some regions pass into shadow, others plunge into the sun-light. As Goethe has said in Faust:

> "And swift and swift beyond conceiving,
> The splendor of the world goes round,
> Day's Eden-brightness still relieving
> The awful night's intense profound."

We draw nearer. In the field of light the water divides itself from the land as on the creation day of the Bible. . . . there is America of which we have spoken, a rock between two seas: there by the northern lights are the ice fields of the north polar lands whose highest summits man has never climbed. * * *

> "The ocean tides in foam are breaking,
> Against the rock's deep bases hurled,
> And both the spheric race partaking,
> Eternal swift are onward whirled."

But it fares with us as with a swimmer who strives to reach a shore: it lies in the distance all laughing and shining in the sun-light with its white beach and beckoning blue hill slopes—yet as he comes close to it the breakers encompass him from all sides, the waves rush in—he sees no more. So we sink suddenly into the atmosphere of the earth, layer upon layer into the thick vaporous mantle which like a warm fleece blanket shuts out from the surface of the earth the brilliant clearness of the stars and also the terrible degrees of cold that eternally chill the world space. It was this light-reflecting vapor mantle that from a distance gave to our planet the appearance of a splendid star flower. Now we cut into a heavy cloud layer and for a while see nothing at all until the damp veil vanishes and before our view at last lies what Columbus once day after day saw around him, even to the horizon: the sea.

There it stretches itself. Night lies upon it, for we have entered the side turned from the sun. The mist veil is torn apart,—above us like a vault lies the star dome. Yonder extends the milky way—a perspective view into the winding planes of the fixed star spiral. In our swift fall we have lost our cosmic ship, the meteor stone. It grazes the earth's atmosphere, glides only through its upper lay. Yet this tenacious medium, tough as pitch compared with the free

ether of the star space, does not let it loose again; like a fly it is clasped in a net,—it is hindered in its course, it twists,—as a spark is thrown out when a wagon wheel is checked on the pavement so heat arises here also—it glows as a shooting star, as a fire ball that increases to a white heat. Finally it bursts into brilliantly dazzling sparks. After a long while the dull thunder of the explosion comes down to earth on a slow moving sound wave.

The cosmical career of the stranger is ended. An invisibly fine metallic rain of nickel and iron balls of microscopic size go down into the ocean. If after years some investigator makes a test of the sea soil he will find there tiny balls —pieces of metal from far off star space that have increased the mass of the earth by an infinitely small amount.

But now take note: all that we have thus far met with has been merely the play of inorganic, not living things. The fixed star system, the earth as a star, the changes of land and water, the air a loose mixture of elements, the ocean plain a liquid combination of hydrogen and oxygen which clings to the hard planet body over many square miles and in some places to the thickness of four miles—in all of these the idea of life fails completely. The sun-light flies to the earth, yonder block of meteoric iron

explodes in the atmosphere,—these also are only cosmical movements of inanimate forces.

But what is this delicate shimmering light that suddenly begins to sparkle on the ocean surface itself? Is it the moon rising and casting its shining silver reflection over the throbbing water?

Only the stars shine in the heavens.

It is as though a silver treasure came up with the tumult of the waves. Now it glitters like a display of jewels, and again it exposes a broad transitory silver plate. It sinks and again it is there. Yonder are the green emerald and the violet amethyst of the jewel. It tumbles over and over, moves backwards and forwards, is upon the surface and under the surface. Have the depths given up again the sunken treasure of the old Spanish Armada—or has the sea begun to gnaw at hidden silver veins in the bowels of the planet and whirl the metal upwards? It is the waves themselves that like soda water with its floating pearls are mysteriously penetrated with metallic silver lights. The edges of the waves shine, in the hollows of the waves the light sinks slowly down to a shadow, only to shine again somewhere else in a new upheaval. Ocean Lights!

Again they come, as though all the swarming spirit flames fled from each other,—now reeling they glide to one side, thrust their little heads down, disclose all the splendor of their silver

bodies, playing in a thousand reflections, catching themselves, running, falling in a heap,—it seems as though one must hear a voice—but only a dull tumult comes . . . an enormous black shadow has pressed slowly forward; above it ghostly points stretch toward the stars. Much of the dark object is concealed, yet two giant eyes glow down from their place above, one red and one green; a flash bursts out followed by a sharp thunder clap; now suddenly there crawls from it toward the horizon a bluish snake like light, which moves quickly like a stiff extended tentacle and changes here and there the black horizon into a blue twilight island. At the same time the black hull advances slowly in the silver water and it is as though it pushed through a whirling crater in which the silvery forms disappear quickly and again whirl upward like a top; greater depths have been stirred and swell up to the surface where every movement becomes a trembling springing tumbling liquid glow.

A ship has entered the zone of sea lights. Its keel has aroused the illuminated waves to greater activity. Colored signal lanterns glimmer from the mast, a language understood by travelers on the boundless night-covered desert of water. A cannon is discharged. This also is a voice over the water in the signal language. The refractor searches the horizon like a gigantic flaming eye.

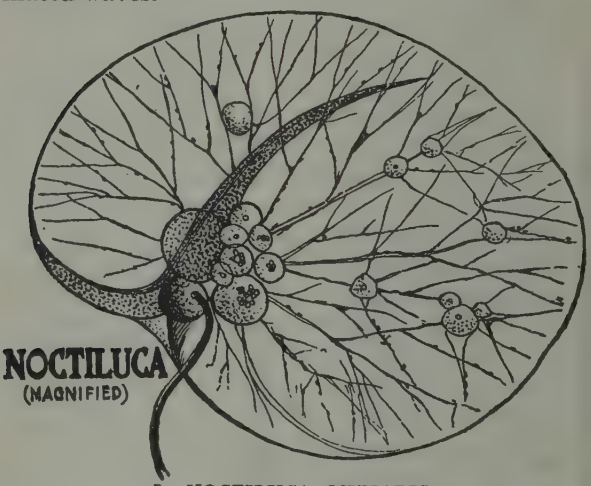
Now then: in this picture we have in fact touched on a new world, an entirely new "some thing" of the planet:—life.

This sea illumination is not cosmic light in its former sense. It is not reflected star light,—or electrical or magnetic light, not lightning or the northern lights, the last glow of an extinguished planet, neither does the water shine phosphorescently from its own elements. It is a manifestation of life and a colossal one at that.

For miles the whole surface of the water sparkles and glimmers in a victorious protest against the astronomical night. The milky way of the heavens stands opposite to the milky way of life. As yonder enormous suns separated by millions of miles of space viewed perspectively blend together to a mild glistening nebula, so here are myriads of microscopically tiny living beings, that one would not perceive at a glance on account of their tiny size, but in consequence of their inexpressible numbers, they also blend together in the field of vision into a diffused general light.

Everyone of these beings emits a fine ray—it shines. It shines with its own body substance, its mystericus gelatinous soft, protoplasmic body. This body appears in the simplest form. The bearers of these sea lights are absolutely primitive forms of the lowest conceivable kind. Life itself appears in them in an obscure incip-

ient form. Animal and plant, the greatest oppositions in higher life are not clearly separated here. If life ever had a visible beginning it must have originated in such simple primodial forms. At the same time they are the dawn of living creation, that, preserved through millions of years, today glimmer to us out of these illuminated waves.



I. NOCTILUCA MITIARIS.

Among all marine animals it best shows the phenomenon of phosphorescence.

Each one of these primitive forms is composed only of a single cell. It feels with the whole surface. It eats and digests since it

seizes and surrounds its prey with its whole body, sucks it out and casts it aside. It propagates since it splits its whole body, falling into two pieces.

Only the most timid attempt at an organic shape appears in these primitive forms. A firm kernel is found in the soft cell mass. In infusorium noctiluca,* numberless individuals of which adorn every wave like gleaming hoar frost, we find a fine feeler extending from the bubble shaped swollen cell body out over the mouth slit, but this mouth does not yet lead into a stomach, but only into the body mass itself. At the most the noctiluca has a diameter of not more than one three hundredths of an inch. With this size it is a giant among the multitude of tiny shining people about it, among the gleaming bacteria. The largest of the bacteria sinks to one seven hundred thousandths of an inch. In comparison with the bacteria the noctiluca is not like a whale among herring, that would be a poor comparison; rather among bacteria three feet long it would rise like a snow-capped mountain. The illuminating power of such bacteria is so strong that one may read the finest writing by the light of a bacteria culture in a glass vessel. For months this living blue lamp will glow, so long in fact

*Abundant on the surface of the water of the ocean and one of the most usual causes of the phosphorescence of the sea.—Trans.

as the tenacious life of these Liliputians continues. Produced by the chemical processes of the living cell this wonderful light, which contains no red and no heat rays, does not consume the tiny gelatinous body from which it streams—the naked human body that plunges into these glowing sea waves which gleam like the liquid metal of the bubbling sun, plunges freezing into a dark cold flood, into a cold light.

This light has remained true to life from the beginning. Just as in the soft phosphoric light of the milky way, single great stars shine out like coiled crystal blossoms, so out of this bacterian and infusiorian sea the larger torches of higher animals raise themselves. Up to thousands and thousands individual cells have come together, have coalesced into an association, forming beings of a higher order, true animals, with differentiated organs in which numerous cells working in common create a division of labor, thus building up higher individuality. The stomach and skin are developed in this higher form of life. An ingenious apparatus for movement has also originated. The old sensitive surface has spun itself through the whole body into a network of nerves. By means of it sensations and motor reflexes fly here and there as though on an inner telegraph system, here a spark carries intelligence to central, there

an impulse is released. This higher animal life divides itself into a series of great classes.

In all of these classes there are representatives that possesses the power of illumination just as in the heavens among the white and yellow and red fixed stars there glow harmoniously down to us representatives of different courses and degrees of development. Like a violet dome the medusa floats along, an embodiment of the low flower like order of plant animals; blue flashes burst from the translucent cray fish of the articulata; like a glowing white cannon ball a colony of the tunicates closely related to the vertebrates rolls into the midst, tiny infusoria like rotary animalcules* represent the realm of the multiform deep sea worms; green vari-colored cuttle fish of the order mollusca, tiny transparent larvae of sea urchins and star fish which in a higher stage become radially flower-like representatives of the echinodermata.

But suddenly the giant of the earth appears among them. Our first picture of life in the mystery of this glimmering night includes alike the lowest of life and the highest, the morning mist and the zenith sun;—out from the bacteria like primordial forms steps man. He it is, that like a mysterious giant shadow suddenly cuts through the sparkling milky way of life, a shadow so heavenward towering that he seems

*The rotifer.—Trans.

to the earth bound glance to reach upward to the milky way of suns in the sky. Man who guides this ship through the solitary ocean where only the animals and the stars shine, is himself the representative of the highest animal order, the vertebrates. Every white glowing colony of social tunicates shows a close lineal relationship to the vertebrates. Itself in every thing else very close to the worm it shows in the life of the larva a fine cartilagenous rod. On this weak rod, life, upward struggling life, has played the most excellent melody on earth. A hard vertebral column throughout the length of the vertebrates has been created from this rod. In the shelter of this column the highest nerve center of the whole animal kingdom was enclosed like a most costly and sacred thing in its tabernacle, until through the work of millions of years it had grown to man's brain. Finally this brain broke over the ban of the old organic structure. Itself like the remainder of the human body built up of myriads of tiny individual cells, a wonderful illustration of the concentration of primitive life, in the light of knowledge it bursts from the bounds of its own body through the discovery of tools. From wood and iron it constructed ships to travel over the watery wastes of the planet into which its lower vertebrate ancestors were once driven from the land. From new combinations of old elements

it created powder and formidable weapons. It filled the tiny microscopic silica shells of primitive plants, the diatomes,* each one corresponding to a cell with nitro-glycerin and with this dynamite burst open mountains. The force of the lightning before which for millions of years the animal world was dispersed in frantic agony, it seized and imprisoned with the firm hand of the investigator and lighted with it the coral-like structure of civilization, the house, the city, the ship. This heap of grey brain matter that controls the ocean steamer and which this iron colossus follows as obediently as the muscles of a hand follow the directions of the nerves, does not need to shine itself like the swarming groups of cells on the shining sea wave under the keel. The searchlight itself bears its sphere of influence even to the most distant horizon. On board there is lively activity. In the light of the lamps something whizzes over-board. It appears like a ball. It seems to slip out of the hands. Yet something follows it downward connecting it with the ship. The ship has stopped. It lies gently swaying on the silver lighted waves. Has death visited this little group of people on their floating fortress; is a coffin being lowered? One gives a coffin to the everlast-

*Dynamite was originally composed of infusorial silica or diatomaceous silica and nitroglycerin. The word now covers a variety of plastic solid mixtures having nitroglycerin as a component.—Trans.

ing silence of the depths never to see it again, but here a line is attached. This is a deed of vigorous life. Burning desire has seized them to know what is in the deepest abyss of the ocean. Natural scientists of a deep sea expedition are on board. A lead with an automatic releasing weight, and with automatic apparatus for measuring temperature and taking up specimens of the ooze has been thrown over-board.

The great deeds of this tool making vertebrate with his giant brain appear in an imposing picture. The noctiluca with a diameter of three hundredths of an inch carries as a feeler a tiny thread on his one-celled body. He feels with it in order to obtain information concerning his immediate environment. Feeling—sensation—here lie, indeed the fundamental and general features of life. Now then—the human animal also sends a mechanical feeler into the deep sea. It is not a part of his body, that indeed is the new and practical superiority of "tools" as distinguished from "organs." But of what a length. The individual man is scarcely six feet high. A feeler that shall reach from the surface to the deepest places of the ocean must be twenty-seven thousand feet long, or more than four miles.* So deep is the greatest sea abyss, deeper than the height of Gaurisankar, the highest mountain on the earth. If

*Equal to a German geographical mile.

this mountain, the top of which has never been visited by man were sunk here the ship's keel would not touch it.

It is mind that descends invisibly on this four-mile-long feeler. But where the mind wanders, there we may go too on the wings of thought. Let us descend with it into the depths. Scarcely have we passed through the layer of shining animals before absolute night surrounds us. It is not the night of the sun deserted side of the earth which meets us here. If when we have gone the first three thousand of the twenty-seven thousand feet, we make a halt and wait until the stars have paled and the sun rises over the ocean nothing will change. No sun rises here. The astronomers tell us of the terrible white mist envelope that surrounds the planet Jupiter, that we have probably never seen the actual surface of the planet and that an inhabitant of Jupiter would never have seen the sun. We have touched a region of our planet where such a layer cuts off all astronomical events. The three thousand feet of water above us swallow up every particle of the sun light, and since the earth does not shine of itself, complete night reigns in these sea depths, the night of a dark star whose sun is extinguished.

Tough, immeasurably tougher than the atmospheric envelope, through which we first came to the earth, this chemical combination water

opposes itself to us. The deeper we sink the more terribly it presses down upon us. The idea of Gaurisankar is made clear to us in a wholly different form. We have gradually taken a Gaurisankar of water upon our backs. Water is lighter than the rocks of the Himalayas, but it has its weight. The globe is only five times heavier than an equally large globe of water, and this is due to the metallic masses of the interior. A mountain of water twenty-seven thousand feet high presses down with a weight of nearly nine hundred atmospheres. This pressure compresses at the same time the carbonic acid in the sea water in such a way that at last it is as though we had descended into a gigantic bottle of seltzer water. If we come from above where the hottest tropical sun lies on the water, it will grow colder and colder beneath until we find almost the freezing point on the deepest ocean bottom. A dark cold planet appears here in the depths like a shuddering picture of the future. We recall the delicate forms of life as we encountered it above in the soft gelatinous lump of a cell. Even man, supported with inner bones, bears this inheritance of bubbling foam, in all the really sensitive parts of his body,—soft as the soft oyster in its shell his brain lies in the enveloping skull capsule—the brain from which all his power proceeds. A pressure of a finger and his wonderful machine

begins to run false and threatens to stand still. Entombed in the shelter of this abyssmal waste, we recall the limited region of the lower air—there where the medusa swims and the human ship steers—the protoplasmic human membrane is only possible in this layer, this thin bark over the stone and water colossus. Already we have cut through it in our flight from the world space, through the atmosphere, into this water depths. To be sure yonder feeler of man, the deep sea lead goes down below us here. But it is only an indirectly animated implement. We can imagine how a human body, the delicate wonder flower of nature, woven of light and air, would be pitifully crushed and suffocated here below. As on the moon, the mind must wander here, not the body.

Our eyes burrow into the watery night while our feet are in the loathsome cold slime of the ground. Suddenly a little blue flame appears. It moves along with zigzag strokes, it is gone. Now it appears far away, it comes nearer. Twice yes three times, it turns, it races, it plays. A larger pale red and green double light intervenes, as quick as lightning the other vanishes. This time it is certainly not the waves that glisten. They are little flames. From whence come these flames in this motionless mass of water? They must be lanterns carried by some

one. Has this uncanny world elves in its water gorges that seek for hidden treasures?

But there are the lights again. In their illumination something of the true outline of this black nether world suddenly unfolds itself. Something resembling delicate branches of tiny trees appears. But no: the lanterns are gone and now the picture suddenly illuminates itself. Pale violet glass-like little apples from which proceed a milky glow hang directly from the bark of the twigs. On the oozy bottom lies a ghostly star whose whole outline is shining. The form is distinct, since to the rim of each arm there is attached a green phosphorescent glow. A shadow glides by, it has the long outline of a black fish. Now it has again plunged into the night, but a flash is seen in the direction in which it has disappeared, in the form of a long streak of golden points, that move so regularly that they seem fastened to the swimming body of the fish.

The riddle is solved. We are in an illuminated aquarium. The fish shine. A star fish lying on the bottom shines. The individual plant-like coral animals shine on the branches of the polyp stems. Gradually it glimmers, glows and sparkles all around. There comes the reddish green double light back. It is indeed a fish, one of the malacosteidae. It carries two lanterns, the one close under the eye shines ruby

red, the second smaller which lies somewhat further back in a groove on the head is emerald green. Otherwise the body is as black as a little Satan. The intense blue fire is borne by echiostoma; it streams from a three-cornered organ behind the eye. Hastily scrambling along, a shrimp works itself backward through the water. Its coat of mail glows red as though it had been cooked; but it appears as if it had been cooked with a glowing sauce, for a glittering slime streams around it like a broad halo. Swaying like an awkwardly swinging pendulum a simple little illuminated body goes irregularly back and forth. Something loses itself behind it in the dusk so that it seems like a glowing berry swung on a thread suspended somewhere in the darkness. The illuminated coral tree solves this picture; the bearer of this wide swinging pendulum passes before it and is in reality only a thick fish with a dark body carrying on the point of his snout a long nose like thread that on its farthest point bears a lantern. This lights a considerable space around the bearer who himself remains buried in the darkness.

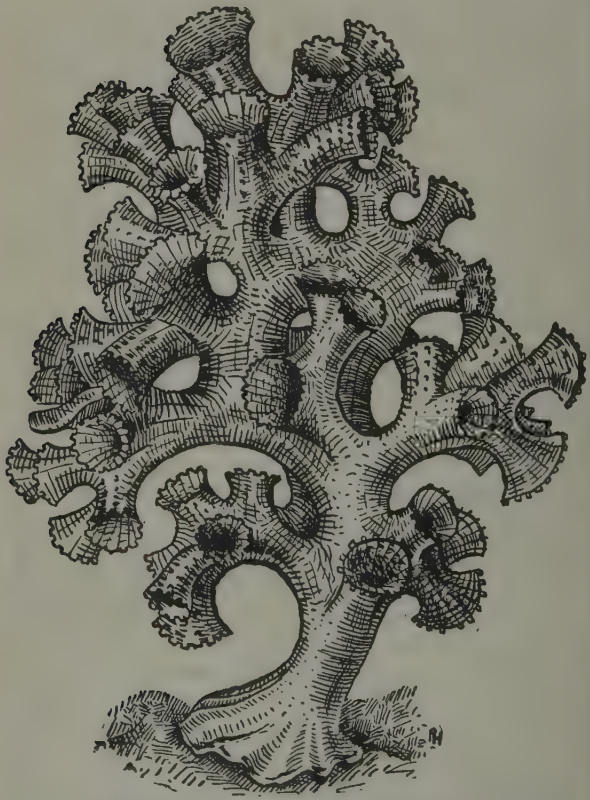
There, suddenly, it is dark again. Perhaps something has disturbed the light bearer; in an instant he has put out his light. Apparently it is under perfect control. After a long time the polyp tree begins to glow cautiously, not all at

once but like a Christmas tree when candle after candle is lighted. One or two of the coral animals in the tree like colony illuminate themselves first. Then a signal runs along the general nerve which unites the individual polyps, and wherever the signal is received a little light flames up anew as if a lighter went along a perforated gas-pipe. Meanwhile a pair of snake-like stars have begun to glow on the bottom. Around their red bodies it appears like a wild Arabesque, like a struggling Gorgon head. They lie in an emerald green bed of fire, every detail of their Arabesque revealed. One of these snake-like worms sends out a cobalt blue flame.

In this general light there arise everywhere forms not yet illuminated of fabulously grotesque shape. A pair of giant feelers grope over a field of light four feet and a half wide, produced by a mass of shining sea-stars; finally follows as their bearer a very small shrimp. Horrible, spider like animals with enormous stilt-like legs run swiftly by. A hideous giant louse, ten inches long wallows through the slimy ooze. Far away in the grey twilight beautiful ghostly but problematic forms arise—little palms, with many leaved crowns on high stalks. With astonishment the eye of the geologist is greeted with the marvelous sea-lily (crinoid) of the primitive world,—a firmly rooted animal with a colored palm crown of tentacles about

the mouth. They appear like a tale from the primitive world. They formed sub-marine forests in the Jura period when the ocean with us yet reached to Swabia; in our German states their stems lie, their far branching feather-like crowns transformed to stone alongside the Ichthyosaurius. Here beneath the deep sea where storms never come to roughly touch the fragile lime discs and the bewitchingly bold and intricate pattern of twigs and branches they have found a last asylum and here they wave their palm arms in the pale light of the shining fishes like a vision of a world that ten million years ago existed in the blue light on the surface of the planet.

Wherever this animal forest is open to view there appear strange stiff crooked forms, hoary dwarfs all bearded and then turned into stone. The lime appears to have overcome them. Their beards are covered with snow-white crystals; their feet have been transformed into crystal needles that have bored three feet into the oozy bed. They also live. They are glass sponges whose structure of finest filagree work is spun with foamy thinness from silica,—glass whose fragility is only possible in the stormless depths and that is so gloriously worked out that when the first specimens were seen they were thought to be examples of the most delicate masterpieces of Japanase glass work.



II. GLASS-SPONGE OF THE CLASS HEXACTINELLIDA.

These are found only in deep water and little is known of their habits.

Yet at this moment it is as though dazzling fireworks were discharged over this delicate illumination. Blue, red and white fire balls stream forth from above in an entrancing play of colors. A host of shining cuttle-fishes have shot into view and are unfolding their arms and bodies and slowly settling down. Each one of these cuttle fish carries twenty-four colored light balls. Around each one of their great eyes hangs a string of pearls, of which the largest is of ultra-marine blue while the others shine like opals. Three giant chains encircle the body in which dazzling white and mother-of-pearl rings alternate with variegated ruby-red and sky-blue. The two main tentacles in the midst of the whole mass of tentacles move in an endless whirl like wondrously colored precious stones, or the rain of color from the crown of a bursting sky-rocket.

We are not simply in the deepest ocean. We are in by far the greatest depth of the earth that man with all his tools has ever directly reached. Above this depth extends the beach line where we bathe, higher than the highest ice tipped mountain. On the plateau beyond the beach stand our cities. From that height we have drilled holes in the plateau. The deepest goes down six thousand feet into the stone, but that is still less than a quarter as deep as this ice black watery cellar. Yet animal life is still found

here almost like that above on the phosphorescent waves of the surface that break horizontally against yonder flat sand beach. A wonderful picture unfolds itself to us. This mighty column of water, of Gaurisankar height that presses down upon us with a weight of nine hundred atmospheres is throughout its whole length occupied with animal life. The great picture suggests yet greater thoughts. What possibilities life must possess to conquer the opposition found in this water column of five and a half miles! Above glows the tropical sun, below it is cold to the freezing point. Above on the equator there are three hundred and sixty-five times twelve hours of clear day, below eternal night. Above only one atmospheric column, that stretches itself over the blue surface toward the warm sun as a weight on the body, below nine hundred atmospheres.

We meet here an imposing power of life, the capacity of adjustment.

The air balloon, a result of man's skill, is so constructed that it rests suspended in our atmosphere or moves with its currents of wind as though it were freed from gravity. But if it presses too high, into a layer of air too thin, where the pressure of the atmosphere no longer corresponds with its adjustment, its bursts violently.

The deep sea fish which man suddenly

snatches from his abyss bursts exactly the same for it has just as mathematically adjusted itself to the colossal pressure of the water in the depths. The capacity of life to give light that in the glowing ocean above merely bids defiance to the short astronomical night serves here below as an actual substitute for the sun. Yonder shining fish glows not merely with its whole skin, it has created especial light organs for itself. That profound saying of Goethe's that the eye could not see were it not itself "radiant" has here found a wonderful exposition. In the case of yonder black fishes, that like gnomes slip past with little blue lanterns in their hats, there is placed in fact near behind each "seeing eye" a distinct "illuminating eye." The large real eye peers out, but what signifies this gazing in the absolute deep sea night? There flames out behind it the illuminating eye. It shines with a blue gleam beyond the "seeing eye" and like a searchlight throws a band of light into the stygian black water. The dimly illuminated outlines of objects suddenly appear. The seeing eye is able to act, to perceive,—it sees. It is the same will that peers and examines and that also releases the light. From the same central place, the brain of the fish, the nerve of sight goes to the eye, and a more direct nerve to the light organ. Within, this organ is constructed almost exactly like an eye. It has a concave

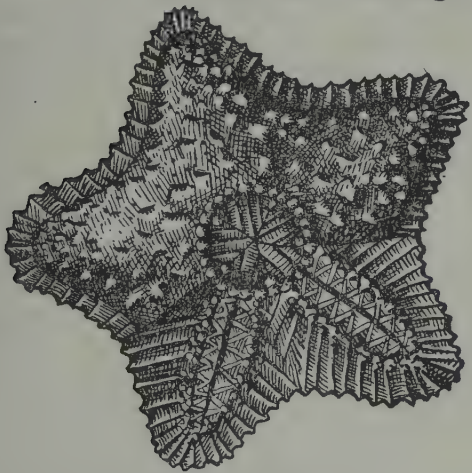
vault and a transparent lens. It works, however, in the opposite direction from an eye. The light starts convulsively with the irritation of the conducting nerve. The concave mirror and lense throw the light far out like a good lantern. Through this light the nerve of sight receives its irritation and communicates backward to the brain as a weighty piece of news, the outline picture of an approaching enemy or a comrade of the same species. A long journey was necessary before all this could come to pass. The fish is an animal high in the scale of life. Millions of cells go to make up its body. In the association of these cells an ingenious division of labor appears. In the one-celled creature the whole surface of the body glowed. Then this capacity concentrated itself in two spots of the body, two groups of cells of the association. Permanent eyes that see for all the other cells have been developed and a central place, the brain, directs this seeing for the good of the whole cell community. Exactly in the same way the power of irridescence has developed. With each one-celled noctiluca the whole surface of the body shines. Then this capacity also was concentrated in a special place, especial light organs. What place more suitable for these than just near the eyes themselves! The directing power of the ruling brain has a deep significance. As the eyes of the higher

animals have special protective coverings, especial lids, that close them when a danger approaches so the illuminating apparatus contains the possibility of extinguishing itself conveniently at desire. There, the ghostly blue flames start apart in a trice. Their lights have suddenly shown the little fishes a great hideous fish that rushes upon them with open jaws. It were much the better for them if they were to instantly extinguish their own lamps so that the enemy should not see them. This enemy himself has as yet displayed no lantern. He only gazes with gigantic eyes into the darkness, to discover here or there the little blue lights which betray to him the victims he desires to devour. In this way he has stolen up successfully; but the blue searchlights of the little fish finally struck him and betrayed him. Before he could close with a snap, the searchlights were all extinguished, the game flees in the welcome darkness. Then suddenly the hunter himself throws out a star like green fire, he has set his light organ that can be regulated at will into action for the first time. Alas for the little fishes! Now the great fish sees them in the glow of his own searchlight. We understand: the pursuer like the pursued has here the need of being able at will to extinguish and kindle his lamp. If the little blue fishes meet smaller ones that they themselves can eat they will act in the opposite

manner. They first creep in the dark upon the little illuminated fish and then when the small ones turn off their lights they plunge all into light. There comes again the fish with the illuminating apparatus like a glowing pear oscillating on a long thread from his nose. He is a sly one who makes capital in both ways. With the glowing pear he produces the harmless impression of a tiny little animal, a glowing worm that peaceably seeks its way with its lantern. Immediately the blue flames of the fish that are hunters of such worms close in near and appear in the light circle of the pear. It is their destruction. The pear is here a decoy. Attached to it but himself in the darkness behind, the actual possessor appears for the first time, an enormous robber fish. In that moment when the little hunters of the supposed worm are illuminated and made conspicuous the dark giant bursts upon them and seizes the nearest in a certain grip. The deceived hunter is now himself a victim.

Hunter and prey! The little fish would eat the worm; the large fish would eat the little ones. Again in mind we wander through this whole terrible water column of five and a half miles in height. Such a hunting ground throughout the five and a half miles of water. Now we understand why life has climbed all through this colossal tower from the sill to the

roof, whether it be from above down or from below upward—why it presses on from the hunt of the deep sea fish up to the sea lights and from the sea lights of the surface under the stars even to this night in which the stars of heaven never shine. There is a conflict through these five and a half miles hunting and being hunted



III. STAR-FISH.

From the lower half the shell has been removed, showing the interior.

in a struggle for life. Hunter and prey! Every one of these fish must eat. Behind every little flame in this illuminated aquarium stands an open hungry mouth and a grumbling stomach.

The star fish that crawls slowly over the ooze in its emerald green light, has a fierce greedy mouth like an inverted flower on its underside. Blind sacks of its stomach reach into each of its five arms and near the top of the star an anus throws out the undigested remains. The delicate sea-lily has a mouth, one yawns on every shining rose of the polyp stock, wild eddies constantly pump nourishment in and out of the sponges. But in every one of these hungry creatures is placed a second tremendous power, born with the life principle and great in its consequences.

All life is able out of itself to create new and abundant life.

When in spring the golden dandelion blossoms crowd in thousands on the green meadows a lovely wonder accomplishes itself for the playing children who in their joy, however, surmise nothing of the great secret of nature. At the height of its power, this golden star turns itself into a white silken ball. A child's mouth blows the ball asunder. The delicate tissues fly away; like tiny elves the little pieces journey off. But out of every little elf blown away on its aerial journey will come new dandelions.

Every one of the creatures in this five and a half mile water column has this power at some time in some form to develop an elfen ball like the dandelion. From the cell unity of its body

a swarm of single cells separates itself quietly, without a struggle. Everyone of these cells possesses the power to re-create a being in its own likeness. Two strange cells must often come together before this. In the lowest forms of life, however, this is not necessary. Whoever can penetrate through all this water will see measureless streams of these germ cells. Every animal in this water firmament is like a little sun that draws a whole milky way of new suns behind it. In the blue lap of these waves millions and millions of these silken balls appear: the waves themselves blow them asunder and carry the germs to their places.

But where is the firmament that could permanently find place for all these stars, and where the world ocean that could offer permanent room for this measureless multiplying capacity of life.

The fish that swims above strews three million eggs in the waves. The shell-fish on the rock throws out a million of young shell-fish. Let us imagine ourselves as a bacillus in this water. Four million cubic miles of sea-water comprise all the oceans of the earth. The bacillus, one of the lowest of all forms of life, would be a microscopic point, with a length of one thousandth of an inch and a thickness of only one three hundred thousandth of an inch. We think of ourselves as on a primitive creation

day, when this whole four million cubic miles of water was still absolutely empty of all life, and like the golden egg of Indian folk lore merely one single tiny microscopic bacillus point were sunk in this millions of cubic miles of ocean. In this little point, however, the great life principle of generation rules. It eats, grows fat and at the summit of its existence divides itself simply into two identical parts: the very simplest form of reproduction. If after an hour both of these portions had become ripe for division there would then be four, after three hours eight. After twenty-four hours we find sixteen million seven hundred and seventy-seven thousand two hundred bacteria in the giant ocean. What would happen then! All these sixteen and three-fourth millions of bacteria would occupy the space of only one-fortieth of a cubic millimeter in the midst of a flood of four million cubic miles of water. But the multiplication mill grinds on. Two days pass. There are two hundred eighty-one and a half billion bacteria. After three days four thousand seven hundred and seventy-two trillion. We will suppose that these bacteria have, as so many have, the power of illumination. A glow suddenly appears in the water. It grows and grows. Now the whole surface of the ocean begins to shine in fabulous ocean phosphorescence. But this phosphorescence penetrates into greater depths:

the whole water column to the very bottom shines in magical blue like the water of the grotto at Capri. The hour hand stands at the middle of the fifth day. There is no more night on the earth. In the heavens it is as though a new self-illuminating star had appeared. The whole ocean to its deepest abyss is a blue glow. All of its four million cubic miles are penetrated with bacteria. The number of individuals requires thirty-six places for its enumeration.

This vision is a tale. No single bacillus has ever reached this limit: but something else has come at least near to it, that is Life as a whole. Falling once as a golden egg into the flood it has searched out a way into approximately all the breadth and depth of the ocean. The surface glitters in silvery phosphorescent light: it is above. In the depths glow the colored lanterns of the deep sea fish: it is below. An enormous conflict appears between these two poles of the water column of five and a half miles. The struggle of reproduction with space.

At first one layer of water swelled with life until the space became too narrow through this incessant multiplying power. What now? Should the whole mass go to destruction, stop its production through lack of space and nourishment? Before that came, another experiment was tried. A wandering out into a second layer. The conditions here were different, the

pressure different, the light different. But the mass pressed on. It paid to experiment. The struggle of this creative power with space turned into a new great struggle: the struggle for adaptation. Layer upon layer was a new environment to be conquered by life.

It has been the great thought of Darwin that this struggle for adaptation has been the means of bringing life to its present greatness. He first pointed out the tremendous power of adaptation. We thank him for having pointed out the principal lines of evolution. To him the great honor belongs of having shown how evolution has proceeded from the one-celled primitive creature up to man. But we do not overlook in the depth of this thought the little words "its force." It is only in life that the capacity for evolution and the power to release and develop the struggle for existence resides. As a little weak mass of protoplasmic matter the primitive cell sank into this unending ocean, why did it not remain lying in it, remain what it was, like the nickel iron ball of the evaporated meteor with which we began our journey? Millions of years passed and this little lump of slime is a fish with an abundance of organs, with a brain and eye and lighting apparatus. Millions more and the fish is a man, who on his trans-Atlantic steamer journeys from continent, locating his position in the water wastes with a magnetic or-

gan—the compass, reading the time from the stars, and lighting his path with an electric searchlight. All this happened because there lay a limitless abundance of possibilities in that little lump of cell stuff. If one does not alter the conditions, then the great fundamental law of persistence that holds the furtherest star forever in its course will retain its full value. But if the conditions are changed the slumbering mass of force in this cell may come to a complete awakening. More and more it develops, strengthened by demand, until form after form struggles up, the star-fish and the medusa, the shell-fish and the fish, each one a glorious adjustment, a developed possibility of the first cell. Finally we come to man, the comprehensive crown of all adjustment, the most absolutely adjusted form of earth, who rules the steamer above from which the deep sea lead hangs down five and a half miles deep.

But all this enormous power has lain in a simple cell? In a microscopic lump of protoplasm without organs? This point of slime could have held all the fancies of an existing world ocean?

The shining deep sea animals have been frightened away by some disturbance. Now it is a completely black night down below. In vain the gaze peers after something. Night lies also on all our questions, the night of mystery. Shuddering the sensitive hand reaches for some-

thing new in this great depth. It touches not hard rock, but a tenacious ice cold slime. The lead that has come down from above is embedded in it. Now a pale glow shines far off, it is distant passing animal light. Something moves in the slime, disturbed, it writhes around. This slimy ooze also has its life, the extreme of life-adjustment. Fish lie in wait, crabs plow themselves along. They lie in the slime like moles in the ground, and like these moles, their eyes have almost wholly disappeared because they did not need them. So these fish and crabs are blind. Here in the slime, shining is no longer of any use. The seeing eye which no illuminating can help is wholly superfluous. So the economic principle of adjustment has removed it. In the black skin of these fishes there remains no longer any trace of an eye. The crab there that feels with its delicate antennae through the slime bears ghostlike yet, an eye-stalk but the point is empty. With him also sight has been abolished. This process of adjustment goes back to the earliest times. Many million years ago when the deep, deep sea stood over Bohemia instead as today over the abysses of the South Sea, trilobite crabs lived in the ooze of the bottom and they then possessed no eyes. It is as though when we plunged into this deepest abyss we plunged at the same time into the most primitive times. The millions of years of the earth's

history of life spread themselves over us like this five and a half miles of water. At that time had the cell already risen to a crab? But where is the answer to our question? The millions of years do not solve the riddle. Millions of years alone do not give such power to the cell.

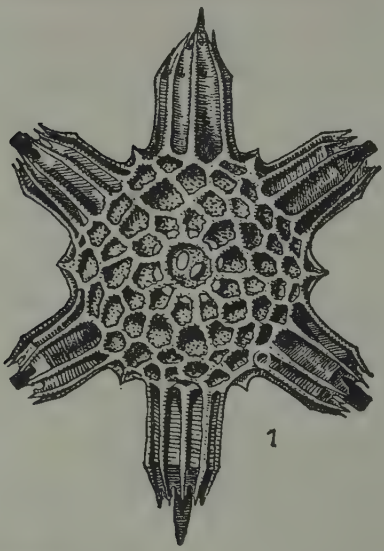
There lies the lead of the investigator. Let us examine somewhat more fully this ingenious apparatus. An automatic self regulating microscope is utilized by it. United with this is a searchlight. There rises a smooth rocky cliff in the background. The lead apparatus has brought up a fine specimen of soft slime. Now it sinks under the microscope. The reflector seizes the immensely enlarged picture—only the middle of a little point of slime, a round field of light appears on the surface of the cliff and there moves in it, magically illuminated, a wonderful picture.

Twenty silver lances of most perfect workmanship radiate from a central point in all directions with the most perfect mathematical symmetry. Each of these lances bears in the middle of its shining shaft like a pierced trophy a rhymically regular trellis work shield. And since these shields in the middle of the lances bend symmetrically downward they construct in the space around the center a pierced trellis ball. The outer half of the lance is tipped with a gorgeous three-cornered summit like a glitter-

ing spring anemone, while the inner half of the shaft appears like a massive frame work through the meshes of the trellis. On the perforated arch of this trellis work are suspended almost like a breath many hundred of the finest silver filagree shafts, each broken into a many notched zigzag line, all of such extreme delicacy that they quiver like a kind of silver steam over the perfectly visible trellis ball and its support. The material of this work of art appears to be of silver metal, but at the same time light shines through it as though it were a crystal mass, that only in its bending throws out silver reflections.

A slight pressure of the apparatus and a second tiny microscopic point extends itself before the light circle in the same large manner. Out of the same material, in similar fabulously beautiful workmanship appears a silver crown. It is the familiar shape of our ornamented treasure, the old holy form of a ring above which the arch of the crown makes three crossing half moons. Between the three arches an ethereal transparent trellis work spins itself. A new picture, and this crown is transformed from its imperial shape into a wild fancy, into the fantastic diadem of a water sprite, circles and arches cut out of jagged coral branches, a silver thorn crown, but the thorn crown of an artist, every little filament regularly arranged. In the follow-

ing picture the crown form is wholly left. There appears a colossal arabesque, a fabulous chandelier fit for the throne room of the water sprites, decorated with exaggerated heraldric antlers. Now appears a trellised ball with spears but this time the structure is fundamentally different. As with the exquisite Japanese work, there are two balls, the smaller one lying concentric in the middle of the larger. Six rods hold the inner one in suspension. These beams extend spear-like outside the outer ball, branching starlike in all pricipal directions. They do not end in weak lance points but in strong gothic cruciferous flower forms. So it goes on in quick succession, as though there stood before us a princely collection of silver prepared specimen after specimen for the Cellini. Gorgeous helmets, a part in fantastic form, a part strikingly calling to mind the familiar forms in our armorial museums, shirts of mail, chain, Saracen shields, crosses, patterns of our familiar stars of orders from the black eagle to the iron cross, the most artistic baskets of twisted silver, bowls and tankards, vases with the famous pierced pendant covering of the costly old Roman specimens. Last appears a true point lace of silver cobweb threads, and a trellis ball with all the meshes over-built with tentlike pyramids. These are of silver wands each one of which bears on the sum-



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2

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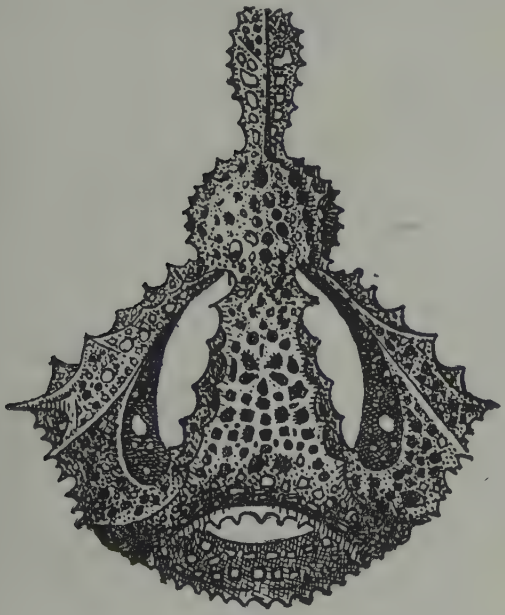
IV. A GROUP OF RADIOLARIA.

1, Hexacopus nivalis. 2, Trissocyclus sphaeriduim. 3, Acan
thodesmia corona.

mit a peacock crest of a dozen unspeakably fine miniature battle axes.

We cast our eyes down for a moment to the loathsome ooze in which the odious blind animals



V. RADIOLARIA.

conceal themselves. What means this sudden development of art, this ethereal melody, this entrancingly aesthetic picture? To produce one

of these masterpieces human skill of great excellence would have been required for years. The real excellence of these helms, shields and balls is such that human hands have never outdistanced them. In fact they have produced at their best objects greatly inferior to these. It is a question of a form of the diameter of one hundredth of an inch or of much less, of a point at or below our field of vision. Indeed in the deepest abysmal depths of the ocean almost the whole slime consists point by point of such miniature forms. The material is not metal. It is silica, the material of which rock crystal is composed. This silicious mass holds its own against the tremendous decomposing power that is constantly exercised below by the colossally compressed carbonic acid of the sea water. Masses of lime could not remain in existence. The human skeleton of lime stretched on the bottom of this abyss would in time be completely dissolved. But these skeletons lead us in the right direction.

The ooze itself has not, through some mysterious pressure or otherwise outside circumstance, crystallized itself into these wonderfully beautiful art forms. Our human bodies contain within them as a support a firm lime frame work, that is the skeleton. The coat of mail of the crayfish is such a frame, as is also the shell of the snail. Everywhere we see life make its soft

cell structure firmer through such a permanent stiffening. But it is not merely lime that is used. If we were to cut into the well known horse tail with a pocket knife the blade would scratch on something in the body of the plant. It is enclosed silicious material that the metal strikes The silicious wonders of the deep sea slime were also in the same manner once constituent parts of living bodies. From the bottom to the top incomprehensible swarms of microscopic little life forms inhabit this enormous water column. They are called radiolaria. In order to hold themselves balanced in the water they develop in their small gelatinous bodies a tiny skeleton, a kind of float of silica. They carry these as long as they live. At the close of the animal's individual existence the float sinks into the depths like the skeleton of a man. Since their numbers are incomprehensibly great and they are constantly recruited through the creative principle of life there pours down from the top of the five and a half mile column an invisible shower of cast-off dead silicious frames. They accumulate on the bottom, heap themselves with the passage of thousands of years to a thick ooze, so thick, that yonder blind fishes can hide themselves therein. But the hard silicious art form itself remains unchanged in this ooze. Each species of these silicious animals has its especial style of architecture. At

present we have come to know four thousand different art forms, of which the deep sea ooze like a true museum has preserved innumerable individual specimens. Doubtless there are thousands more.

Now then: each of these radiolaria consists of only a single cell. They belong to the simple original primordial animals. Yet in their case the single cell was set the problem of building a little silicious float in at least four thousand different styles of architecture. It has found four thousand different answers. With playful fancy there have been introduced into these answers four thousand different forms of art, rhymically pure, so to speak, melodious solutions. Here is an abundance of ornamentation. Man has obtained such results only through great efforts. Art in its human history appears at first as a crude attempt, then develops into finer and more perfect forms so that we measure the stages of society by their æsthetic attainments. But here in this first life in the simple cell art appears ornamentally expressed.

Like a flash this disclosure of the slime in the black deep sea night elucidates our question for us. Life which carries within itself the limitless abundance of power of answering so simple a question of utility with four thousand inner possibilities and these clearly possibilities that

are based on internal regularity and harmony; such a life that carries in the simplest cell such an "abundance of features" this may indeed be able to give always exactly the answer to the thousand upon thousand of questions concerning adjustment on this planet, and can do this again and again in the overflowing abundance of its wealth of forms and always hit the nail on the head. These radiolaria themselves are not large wonders of adjustment. Their structures as a whole have remained to today bounded by single cells. The way is long on the side of adaptation from such a radiolaria to a fish. When "the form capacity" breaks forth there is something almost playful in the results. But the most marvelous thing that appears in this "play" is the boundless wealth of possibilities. It is the fanciful child out of which life will forge the strong thinking man competent to fill his place. What appeared as "play" in these four thousand forms, was indeed the crowning treasure of life, out of which all the marvelous wealth of forms of the higher stages would proceed, the exhaustless treasure on which adjustment rests and out of which life can be modified as the demands of the environment become greater upon the myriads of individuals thrown upon this many featured planet in a fierce battle for growth and room. Without this power which displays itself in these four thou-

sand artistic forms of radiolaria the individual cell would lie today in the sea like the motionless little ball of meteoric nickel that mixes here with the silicious ornaments in the deep sea ooze. Through it has not only come the medusa and fish, but also man who sinks this deep sea lead five and a half miles in the ooze in order to solve the question, how man has built up a perfect world knowledge and with its help will finally conquer to perfection this old world planet. This dark deep sea abyss holds at the same time a profound significance for human art. In it the endless fancy forms of primitive life yet rule. It is in no way an accident, but has the deepest significance, that our human aesthetic feeling, our art creating fancy, has reproduced as a whole the ornamentation of the radiolarian skeletons. With us this skill also appears a play, but it is at the same time a play with a truth therein: no idle play. It is in fact the sum and prelude and contains the slumbering power that is to be put into practice. At the right hour there will proceed out of it the highest skill and higher stages of development, just as once in the playful realm of possibility, adjustment through the demand for development proceeded from the one celled being up to earth ruling man.

Twenty-seven thousand feet of water over us and then the endless open water mirror. Out of

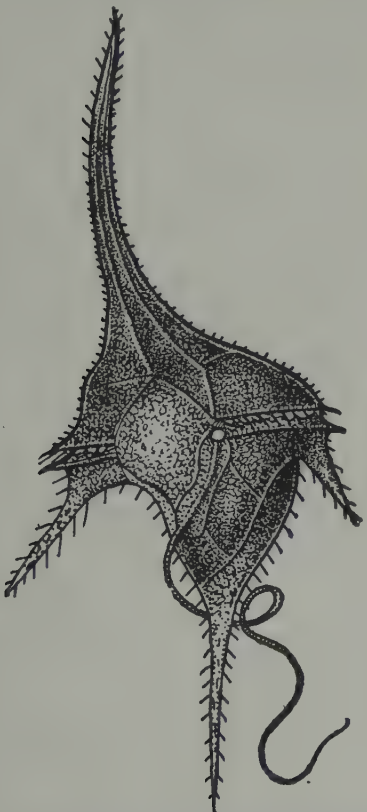
it rise many beaches, islands, continents; glaring deserts, granite mountains, glaciers, ice wastes of the poles and over these a vaporous mantle of atmosphere, a newer lighter ocean, in which the mountains and polar heights rise again like higher cliffs, about which the wind currents move, and on which the clouds accumulate like white foam masses. Into all this the cell seed of life was sown, with its endless inner power of invention and the power to bring itself further into harmony with all the endless possibilities of this extended planet structure. What a spectacle it gives!

Filled with shuddering by the abundance of forces we have let go of the branch of the shining polyp stock. Under us mingle the glow and glimmer of the little imps, the abysmal water sprites. Slowly as we ascend there flows from above into the water a pale light, a purple twilight. The outer universe makes itself felt again. The sun begins, as in the Biblical narrative, to lighten gradually the deep black water, "And it was light." In this light there grows before us in the upper water a new ghostlike strange world.

There descends down through the water mountain something resembling the colonnade of an enormous sunken temple. Yet these columns do not stand firmly. They appear soft in an elastic element. They move themselves, rock,

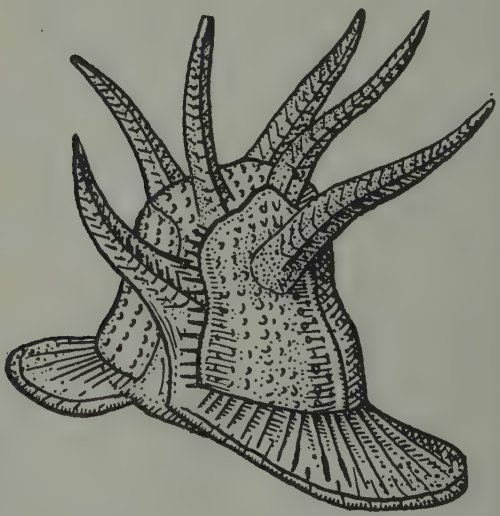
float up and down. We know that their feet rest on dark cliffs. From there they creep up to the light like giant worms, interlacing above in the crystal firmament of the ocean surface into swaying loosely joined great rafters from which go down swinging pillars. Suddenly as the sun sends in its cone of rays perpendicularly, there shimmers in this primitive forest encircling the worm-like columns of the strange style of architecture marvelously gay colors,—stratified flaming red, shining emerald green, of under sea meadows, golden brown, and azure blue as though the deep had absorbed a piece of heaven.

We are in the forest of sea weeds. For the first time, as we approach the sun-light, we have come in contact with the second great fundamental form of life, plants. Within the ocean itself near its illuminated top, these plants meet us in the form of a submarine primitive forest of dimensions reached by no land forest. To be sure plants are the most primitive of created things. They do not nourish themselves like animals from other living creatures. They create their food by their own power, directly out of the earth and air. To accomplish this purpose they have need of an assistant that they can not do without. The green cooking pots of the cells, cook only when the distant cosmical light, the light energy of the



VI. DINOFLAGELLATES OF THE PHYLUM PROTOZOA.
These forms stand on the border line between plants and animals. They possess chromatophores which enable them to feed after the manner of plants, but also have a mouth, which is an animal characteristic.

sun, touches them directly. So we seek in vain for the living plants in the deep-sea, whither the animals penetrate, feeding themselves on



VII. DINOFLAGELLATES OF THE PHYLUM PROTOZOA.

These forms stand on the border line between plants and animals. They possess chromatophores which enable them to feed after the manner of plants, but also have a mouth which is an animal characteristic.

other animals or on vegetable material that has sunk down. When there is no light there ends the possible realms of these sun children of life.

At a depth of nine hundred feet are first found little individual swimming plants, tiny one-celled, like the radiolaria, packed in delicate silicious houses. The more the water opens its crystal transparency to the sun, the stronger the plant life grows. The free swimming individual cells combine themselves here into associations. They build at first only a very simple web. But immediately there appear even here in the water the characteristics that so definitely separate the exterior appearance of many-celled plants from the true animal. The plant does not strive for horizontal growth after it has established a many celled colony. Its mathematical measure is vertical. Underneath it digs down with its mouth—the sucking root—perpendicularly into the ground. Above it opens another mouth—the green leaf—demanding a vertical sun.

This sea-weed forest needs ground to which to attach itself and from which it can extend upwards. An old botanical tale told of the Sargossa Sea, free swimming sea-weed meadows of the Atlantic Ocean between Spain and America. At first the tale allowed ships to remain fixed in it, but Columbus sailed boldly through and broke this part of the legend in pieces. Later investigators scattered the second part. The fields of loose swimming sea-weed in certain flowing currents in the open ocean are in

fact only pieces torn away from the real forests, which are attached to the bottom. The streams have heaped them together in one place into a many-branched web.

Whenever the ocean is so shallow that the sea-weed can attach itself to the soil and yet at the same time obtain sun-light from above, the coast of the land must evidently be near. About the base of an island the marvelous water-sprite crowns weave themselves the most and we therefore can not be far from such an island ourselves. The net-work of leaves, however, swims on the surface. If now we mount up we shall see a soft gently swaying wreath formed in the boundless ocean waste about a strange volcanic island which itself bears no forests. Like a naked point it lies just above this incessantly murmuring and swaying overhead carpet of the giant sea-weed forests, a red cone in the midst. The coast, through the incessant gnawing of the water, falls away precipitously with here and these steps of half worn lava streams and pillars of basalt. The breakers burst on the rocks, but somewhat in the distance beyond the shallows where the sunken forest begins, the flood rocks placidly through the gelatinous leafy carpet as though smoothed with oil. Like the branches of an actual forest upon which one looks down from a high observatory so this sea-

weed mass arranges itself in a definite direction with relation to the wind.

We are in the southern hemisphere of the earth beyond the point of the great continents of Africa and Australia. The famous Macrocystis pyrifera constitutes this sea-weed forest. This giant sea-weed raises its thin stem up four hundred and fifty feet long, only twenty-seven feet less than the height of the proud cross on the tip of the Cologne cathedral above the level of the Rhine, until at last the palm like leaf-work with golden brown leaves six feet long held in balance by pear shaped air bladders, unfolds itself on the water mirror. The highest tree outside the ocean, Eucalyptus amygdalina of Australia, is scarcely of an equal height. There have been, however, reports of giant sea-weeds that have measured one hundred and fifty feet greater than this measurement, statements that may well be taken with some reservations. In Behring Strait the Nereocystis similarly unfolds itself, the sword shaped leaves of which alone are thirty feet long; the swim bladder must measure six feet if it is to hold such a frond in balance on a thin thread-like stem, three hundred feet long. A picture of the primitive world suddenly appears at the same time out of the floating mist of such a landscape. In the dim twilight of the creation day the first land rose out of the luke-warm sea in exactly

the same manner as this wild absolutely level naked basalt island hardened out of the red lava flood. Around its base the first wreaths of higher life wound themselves—plants that in the first forms are algae here in the warm flood have become many celled expanding sea-weed. From this first position in the primitive sea, slowly indeed life has crawled upon the land,—as plants that wished to draw nearer to their sun and that threw out their rocking fronds one day onto the warm rocks heated by inner fires and sank thin roots, torn loose by the storm, into the soft volcanic ashes, the first "humus" of the earth. After the plant, animal life appeared on the rocks.

Through the under sea-weed forest shadows wander mysteriously. As the clambering monkey in the leafy top of the primitive forest giant separates the soft leaf work, so colossal animals press through between the soft sea-weed stalks that bending elastically give way before them. As the dark primitive land forests shelter the giant forms of the land animals, elephants and elks, so in the region of the sea-weed forest the largest sea representatives of all species of animals assemble. There wallows in a foamy whirlpool the biblical Leviathan, the sperm whale, with its length of sixty feet, one of the most powerful of all living vertebrates and at the same time a highly devel-

oped mammal. In the deepest parts of the thickest algae there lurk with monster fang like arms, that themselves angle like undulatory sea weed stems the giant cuttle fish, the kraken, a fabulous Scandinavian sea monster, that at last here below becomes a scientific reality. From the rim of the cliff yawns the giant cockle fish six feet long and weighing four hundred pounds. From above there sink, like birds driven by storm into the forest, monstrous colored bells, great medusae of the order cyanea arctica, the tops of which are almost six feet in diameter while the tentacles swarm out ten times as far. These enormous medusae, like the giant sea weed itself, are found high in the cold zone, in fact higher than the sea weed. With astonishment the expedition of Borchgrevink* found a colossus of this kind on the icy cliff of the south polar land.

This picture of today solves another of the problems of the sea-weed forests of the primitive world. In them wallowed the giant cuttle fishes formerly in a firmly rolled spiral case as were the related ammonites (ammonoidea). One of these found in Seppenrade in Westphalia and set up at Munster has a nautilis case that measures twenty feet in circumference. As thin as an eel and of a length of a hundred feet

*Carsten Borchgrevink—a Norwegian explorer. Wrote "First on the Antarctic Continent."—Trans.

the largest mosasaurus wound itself among the herd between the plant pillars, an ocean reptile with yawning jaws and that completely corresponds to pictures of hobgoblin "great sea serpents" of today. Can it be that this "sea serpent" exists at present a persistent water-legend, a species of the old reptile of the chalk age that until today has concealed itself from the eye of the investigator in the sea-weed forests of the boundless ocean, like the surprising giraffe like animal okapi * that we have held to be extinct since the old tertiary period when giraffes and elephants yet lived in Greece, until it finally appeared out of the blue twilight of the untouched primitive forest of the Congo? In any case not far off rises the western coast of America, the inlets of which, these mosasaurs once visited in throngs. On the Galapagoes Islands a hideous, hateful lizard three feet long with a high thorny crest regularly descends to the under sea-weed forests (contrary to the custom of all other living lizards) in order to feed itself on the leaves of the vegetation.

So this primitive water forest was not without its spooks and mystery. In the depths the primitive world and legend twine themselves together like lianas.† A skillful artist could not better typify "Silence in the Woods" than

*An animal of the giraffe family discovered in 1899.—Trans.
†A climbing woody plant.—Trans.

through a grotesque giant animal rising out of the purple deep.

The thick trellis work of the sea-weed separates itself in wider meshes. Just as above, a flock of white parrots leaves the cover of the forest and presses forth into the open, so here, in this soundless world, the slow flowing flight in the crystal medium, of the flower like varicolored shining medusae forms a girdle to the ocean forest. In endless rows these medusæ press outward. The beautiful pearl chain may extend out into the open sea for thirty-seven miles, decking the upper surface of the blue mirror with at least two hundred and twenty-five million individuals. They are the true butterflies of the water-world that like the common white butterfly unite themselves and sail along in numberless flocks. Just as our light soaring butterfly is enticed to the blooming pastures, so this swimmer of the free blue ocean depth, light and blue as the depth itself, gradually leaves the sea-weed forest for the open. Strong and clear is the glow of the sun from above. Now it begins to warm the water, it is as warm as the vibrating air over a summer meadow and there lies the meadow, a sea meadow in the undisturbed light of the clear crystal surface,—a flower meadow of lavish gorgeousness.

Imagine ourselves for a moment far from here in a high mountain. A stiff blue ice stream,

a great glacier presses into the valley. Along its sides lie rude rocks, rooted up, scarred and polished by the glacier itself which once on a yet colder day caught them with its ice claws. Now they are free and the warm spring sun lies on them. Into all the flat places, between the rough blocks, the meadow has crept, the plant carpet has left no place unconquered. In the kiss of the sun, a many colored flower surface has sprouted up out of the ground scarcely yet free from the snow. Shaggy silver white and gold yellow mountain anemones, shining blue gentian and blood red alpine roses alternate with one another in a thick cushion. Like the color pattern of a heavy Persian carpet it covers the whole declivity toward the valley. Over this beautiful Alpine garden hover shimmering colored butterflies and in advance of all a splendid Apollo which carries the red of the Alpine rose in the form of great eye like spots upon a ground of rough frost like asbestos white. But now let this actual picture be touched by the wand of a legendary fairy. The butterflies would descend to the grassy sod. They would grow fast there and become wonderfully beautiful flowers and only the flower leaves would wave tremblingly up and down like the former wings. Alpine roses and gentians would turn up side down, loosen themselves from their stems and rise in a breath of air, the corolla down-

ward and the stamens gently oscillating as though the whole had become butterflies. Over the whole picture falls a blue light. The glacier has stretched out its crystal hand, like a sky blue disk it has spread out over this whole enchanted world, as though to protect its Idyll from the profane world. Only the golden sun ventures in———

We are again in the sea. What was there a legend is here a reality. Above us rise one hundred and eighty feet of blue ocean like a glass disk. A tropical sun glows on it and heats the flood to sixty-eight degrees Fahrenheit, a normal green house temperature. Here also extends a sloping declivity sown over with great isolated rock blocks, all the rock lumps and ruggedness covered by a rich colored flower meadow. Here also Alpine rose, red, gentian blue, anemone gold and emerald green weave a design with each other. The wonder is realized, we are in the garden of the ocean, in the coral garden, and each of these flowers is in reality an animal. They root firmly, plant like, on the ground and stretch the little colored wings of their soft bodies, like flower leaves upwards. The medusae that in the blue above flutter like the butterflies of this garden are nothing but torn off blossoms of the garden itself. At one time they grew as tiny cups, entirely similar to the true coral, from the stem of a polyp or sprouted as

normal buds on its side. Then they loosened themselves, turned the corolla under so that the tentacles like stamens hang dangling down and swarm away, hence forth free moving animals.

VIII. CLADOCORA COESPITORA OF THE HEXACORALLA.

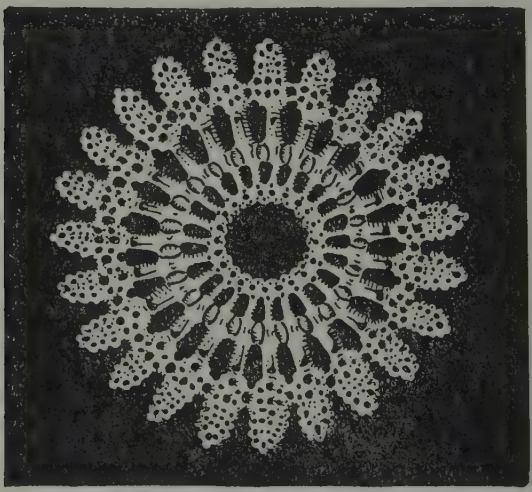
This is a branching coral. The individual polyps are shown here with the tentacles contracted.

Of unspeakable splendor is the richness and glow of color of this species of animal. Here alternate pale blue umbel like coral with saffron

yellow moss coral scarlet red sea-roses, the tentacles of which shine a gold yellow; tubipores out of which branch carmine red pipes calling to mind organ pipes; honey comb coral; blue green poplar coral; and golden brown bush-coral; red-brown mushroom-coral; and the great dark golden flower-ball of the brain coral. Between these move like the shining running beetle of the Alpine sod, yellow and blue black striped mantis crabs, blue-red star-fish, and coal black prickly sea-urchins.

This animal sod in its splendid beauty tells also, in its deepest sense an impressing tale. We have seen life in a wild wrestle in the black cold depths. To eat or to be eaten appeared to be the only watch word. It was animal life that separated from the plant, was no longer able to build the marvelous structure of its foam-like body out of sun, air and earth, but was restricted to "living nourishment." The hardest whip from then on was the struggle for existence, the pure struggle for sustenance. We recall with this the profound thought of Darwin, that this struggle in all its horror is not in vain, but leads to new advance, forcing the exhaustless and purely fantastic forms of life into definite paths. It creates throughout this planet a stable harmonious firmly balanced kingdom. It remains a hard thought that in this struggle for adjustment, for harmony with the total relations of

the planet, the conscious creatures should forever engage only in tearing one another in pieces and should find only eternal disharmony. We think of our human conflict with the earth, on our highest culture, that carries on this struggle now by means of investigation, science,



IX. SEA-URCHIN.

technique. We recall suddenly that out of the deepest and holiest of this culture yet another voice speaks to us, the demand of culture that the struggle for things no longer lead to a battle between man and man. One day the demand

of culture meant to eat each other. One day the moral command was heard "Thou shalt not kill"—not kill men. One day it was announced from a green hill that all men are brothers; that this little mass of men in conflict with the world should co-operate: that mankind has one body and one soul. In opposition to this teaching there have been an endless line of reversions in our cultural life. But since this teaching has been announced it has become the kernel of our culture, and we are concerned with the recognition of these relapses, which lose their importance because they are recognized as such. It does not matter how I name this principle, whether humanity or love or the social question or Christianity. We all know it in its true form whether with or without a name. We will name it the principle of co-operative activity. All men act, according to their idea, co-operatively. They struggle in common for their existence on earth, and for their advance in this existence. Among themselves they do not struggle, but stand upon a basis of reciprocal help. It is clear that this principle does not itself end the great struggle, but it changes the form of it. In place of a struggle of all against all appears a struggle of great groups with others. Within the group itself, however, a harmony has been attained. In the place of struggle some thing positively new has stepped in: reciprocal

help. Sympathy is not, in this sense a genial mistaken philosophy, the discovery of slaves. It is the new life-blood of every group formation, every higher organization of individuals. If, in my body, which is actually a co-operative of millions of cells, I experience in my brain a blow on my hand, it is the most positive proof of the existence of a true co-operative, that stands in opposition to the rest of the world. The active result is not a slave-like fellow-suffering, but an act of help. I choose from the brain the most purposeful act to protect the hand. So I understand, if I hear a man on the street call for help, that he is a man, even if I do not know his name; a man and therefore a member of my great humanity body. The blessings of this co-operative structure are countless, this marking of limits to the sphere of the great battle-field, within the bounds of which complete harmony, unity and feeling of solidarity rule among all the members of the association. In these neutral fields, a practical division of labor is introduced, the guiding star of all human development. In such an association one stands for all and all for one. Each one does not need to do everything; if he especially likes one thing, has one peculiar capacity in which he excels, if he has been richly endowed with gifts either by birth or by some coincidence of fate, all can obtain the highest advantage therefrom and

gladly repay him with the results of the work which a second or a third can perform much better. So, in this great association of human culture we see faculties unfold themselves, a division of labor according to talent is introduced which becomes a great source of concentration of strength, increase of total activity, and of boundless progress. It is necessary to refer only to art, which without this regulation of things could never have appeared. Immediately there appears on this neutral field, where the wild struggle for existence is checked for a definite limited tract, a refinement of feeling, a softening of customs, that in the end is of the highest significance to the whole of the higher form of conflict. This ideal when fulfilled (even in the narrowest circles) makes itself felt as a decided energy. It develops also on the ethical side. In place of the old antagonism of lord and slave, enters the higher comprehensive idea of free surrender to a greater whole. On the completion of this ethical process rests the possibility of the highest culture, the pure unselfish joy in the object of investigation, of art, of philosophy, and a comprehension concerning our relation to the Whole.

Gently the medusa draws itself over the varicolored animal meadow. How far we appear to have wandered in our thoughts. Yet we have only gone up to the apex of the life which has

its beginnings here at the bottom. Each one of these coral animals does not consist alone of an association of cells. That this is true can be easily shown. With a microscope, the living building-stones, the cells, are visible to the eye. They are in such close community that they are fitted into one another. But they are arranged in a firmly regulated division of labor. The cells of the intestinal tract digest only, others perceive only, still others defend. If these do not do their duty those can not develop and vice versa. Meanwhile single independent cells appears here and there like individual pioneers or Robinson Crusoes that seek to show that there ever existed an individuality. They separate themselves from the cell-state as creative cells, egg cells or fertilized cells. The entire power resides in them of founding anew the whole society and creating from themselves a new cell family in which the division of labor will appear once more. This stage of the many-celled corals corresponds to the equally many-celled single body of mankind. The step toward that, which among men we call co-operation, association, is taken by these masses of coral animals which likewise unite for mutual assistance. This colored field of flowers consists of coral colonies closely grown together in which thousands of individuals unfold themselves like actual flowers on a common stem.

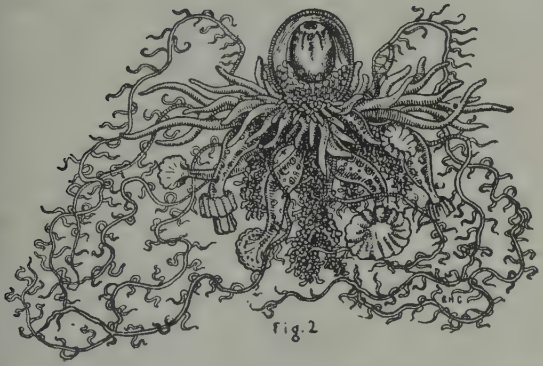
Just as the egg cell forms a new cell colony by division without complete separation (in man as well as in corals) so the original coral creates by side sprouting and partial division an entirely new complete coral, which, however, remains in a sort of union with it. Every individual, however, preserves its own mouth and stomach in the process. From its stomach cavity there proceed branched tubes to the nearest coral on the same stem. The sustaining fluid flows hither and thither—who ever has anything gives to the other and reciprocally. It is no wonder that such a community meal leads to further division of labor in the stalk. Why should all send out tentacles and catch food? Is it not sufficient that one should do this for all? Others can then perform other labor for the general welfare. So it is that in certain associations we see little coral animals with no arms and with no organs for multiplication. They only pump water in and out like living community pumps. These have been well named "drink persons." But their work is just as important as that of the eating persons around them, and with right and justice these that satisfy the thirst of others are fed for so doing.

What is begun by the firmly attached animal flowers is completed by the free swimming. In the midst of the throng of single medusa, a complex form appears. Colored, crystal clear,

transparent as though formed of colored glass, it looks like a medusa. But its shape is different. It is a siphonophere a "staatsqualle." Following the same principle of associated structure a great bunch of medusae sprout out from the first individual. This family does not separate, but like the coral, remains attached by a common uniting canal between the stomachs. A much greater extension of the principle of division of labor is found here. Many of the medusae in the colony have, once that they are attached to the nourishing feed pipe, dispensed with their own stomachs and mouths. They have merely their swimming bell developed as perfectly as possible and carry the whole colony along through their buoyant power. The specialized eating medusa on the other hand, has abolished this bell and has become all mouth and stomach,—like pumpkin blossoms, they sit eternally snapping and digesting along the swaying road over which the bell medusae like puffing locomotives tow them. In the association there are definite "intelligence medusae," that is sense or experience animals, and again others have completely set themselves to the great work of reproduction.

Another point is made clear to us as we look at this wonder picture with its undulating forest of numerous eating mouths and swimming bells. These jelly fish and coral associations

differ from human associations in that at this stage there is the possibility of bodily association. We human individuals merely build a



X. FIG. I. DISCOMEDUSA OF THE PHYLUM COELENTERATA.

To this phylum belong also the corals, sea-anemones and siphonophore.

FIG. II. SIPHONOPHORE.

spiritual association. We do not grow together in flesh and bone. Examples of this higher principle of association without growing together bodily are found here below. There runs a crab, the so-called soldier crab. Pick-a-pack

XI. SIPHONOPHORE.

he trails along a hollow snail shell in which the posterior part of his body is concealed like a hand in a glove. We see even here below under the blue water bell of the coral that great invention of life by means of which man first be-

gan the technical mastery of the earth; the discovery of tools. A strange dead piece of stuff is animated to a "help organ." The ax stretches out the hand, the coat of mail covers the soft skin, the telescope extends the eye, the telephone the mouth and ear; the soldier crab that takes possession of a dead snail shell and draws it as an armour over his weakly protected back, has in principle stepped into the realm of tools. On his shell is a high orange red form, a sea-anemone. It is alive, and since it sits on his shield, it lives "with him," only they are not grown together. Wherever this busy little creature runs he drags it along with him on his snail-shell. Each derives an advantage from the other, life from life, as in the case of the coral and the siphonophore. A portion of the nourishment of the crab falls to the part of the sea-anemone, while the terrible weapon of the latter, its poisonous stinging organ, like the stinging nettle of plants, serve him as a protection. Both recognize this. The sea-anemone leaves the crab only when the snail shell is broken and climbs upon the new one, without stinging him. He lifts the sea-anemone carefully upon him when it is lost, and yet they are not grown together. How could they be; two animals of entirely different species, as far apart as the heavens? Their association must necessarily take the form of a higher, finer

type of association if it is to continue. The course of unity here pursues a higher path. The crab with his fully developed eyes sees the sea-anemone. The organ that in the deep sea we found as a weapon in the wild conflict of all against all has here become an organ of sympathy. At the same time it makes co-operation possible. Nerve need not grow to nerve or body to body. These beings can understand each other as far as their visual power reaches.

The crab and the sea-anemone live without being organically connected. But this wonderful shining yellow color of the sea-anemone brings us to a new example. It does not belong essentially to the sea-anemone itself. Certain cells in the upper surface of the mass of the body are colored golden yellow. These cells exist loose in the mass. They are living, but they live entirely apart from the anemone. It is an animal. These yellow cells are plants. Nevertheless the anemone has not swallowed them as nourishment, has not killed them, since they are in no way digested. They live happily within it. They live in an absolutely free association without eating and without being eaten, only deriving advantage from each other. Their respiration is reciprocally supplementary. The sea-anemone as an animal gives the yellow plant cells carbonic acid and proteids. The little plants on the other hand give oxygen to the

animal. Both therefore do not grow as individuals alone, but they have formed a good co-operative for production.

From the swarms of jelly fish an individual of especial beauty has separated itself. The wish seizes us, in spite of its dangerous stinging organs, to draw nearer to it in order to observe it more closely. Strange, how does it happen to continually avoid us? Does it see us? To be sure the jelly fish has a definite nerve system. It has also a small eye; but never did anyone observe in an otherwise so rudderless an animal and one so closely resembling a torn off blossom, such a careful choosing of directions horizontally. The riddle is soon solved. The jelly fish does not govern itself so definitely, but in its transparent house, in the interior of the bell swims a little fish, four and a half inches long, like a gold fish in its glass. With its large vertebrate eyes it sees us plainly through the transparent walls. With its excellently ruddered, boat-like body it presses the jelly fish in the necessary direction of flight, like a living rudder, and is thus of the highest advantage to the jelly-fish. This little fish is not harmed or eaten, neither does it harm the jelly-fish. They live in excellent association. The jelly-fish affords the fish a house which by means of the stinging organs, is fortified as with hundreds of electric batteries against any other robber-like fish. The fish

sees for the jelly-fish and steers it by means of its intelligence. Neither harms the other: the jelly-fish does not turn its stinging organs against the fish, and the fish does not turn its teeth against the soft gelatinous body.

But individuals of the same kind form wonderful protective associations in this under world without growing together. The strange snake-like fish whose long eel-like body is pushed along by means of fine wheel-like paddles, like screws, of the species, sea-needle or pipe fish, carries on its stomach a bag made of wrinkles. This conceals foreign life and yet it is not an appendage of the stomach and this life is not destined to be digested. This life is eggs with maturing young fish of the same species. They mature in the protection of the parent fish in the kangaroo like sack. Strange, yet among fish and amphibians not uncommon, it is the father who in this case carries the bag and protects the young ones. The mother has laid the eggs with him as in a true nest, which he now carefully bears around with him. There appears here, in a simple form, an association for protection between parents and off-spring. The off-spring is not eaten but is cared for and guarded. This social form begins with the sea-urchin and the star-fish, yes, even with the sea-anemone. Steadily it develops. The monster that sinks down by the coral bank like a rough giant tree trunk

is a sea-cow, although in the form of a fish. Though it has the form of a fish, it is in fact a true mammal. On its tightly stretched mother breast, a young is nursing, that for a month after its birth is nourished by the mother's milk, and in case of danger is protected with violent rage. If the strength of the mother is not sufficient for this protection, the father hastens to help. So the bond of co-operation is formed between parents and children and also between the parents themselves. Long hands are reached out through this bond, the true love-bond throughout the animal world. At a certain stage it is necessary that for the starting point of a new being two cells must unite. This union in itself is not a true social act. It is a normal union, yet in a wholly different form from that found in the siphonophore or the coral polyp. Rather it resembles an act of eating, only with this wide-as-heaven difference, that a harmonious interchange of the powers of life takes place, instead of one individual killing another in order to live on its corpse. In all cases this fundamental fusion of cells, this union of spermatozoa and egg-cell, remains unchanged from the infusoria to man, a peaceful, harmonious, but in its peculiar way, a highly isolated and strange act. Out of this act grows gradually a second significant thing; the great many-celled creatures that for the production of spermato-

zoa and egg-cells have divided themselves into man and wife. These in turn see themselves forced, for the purpose of securing a union of these cells, to themselves enter into a certain relation with each other. With the advance of animal development and the increase of variation, they can not fuse themselves together. Variations are utilized in drawing the sexes together. The sense organs, above all the eye, are necessary in order to find another individual of the same species, certainly in order to favor certain ones in the choice. So the first treaty of peace is formed on the sex side between two individuals. This treaty may at first last for only a moment. Those who are united one minute may declare war against each other the next. The wife spider eats the man in the midst of the act of love. But the feeling of community does not disappear. Finally man and wife form an ideal association founded on respect. Out of this comes a stage of real association for protection. With the sex love comes a union for the protection of the child. At first one of the parents protects the egg,—that immature offspring. Then both must help and for this purpose must remain together. The child has created marriage, the permanent marriage. From father, mother and child comes the family. The family forms a new, unspeakably important center of crystalization in the great

march towards an associative structure. With it love becomes a purer and an enduring social factor. We have this to thank for the fact of our higher stage of culture, that we have raised and ennobled the word love and made it the watch word of our highest spiritual and social strivings. From the sex-love we have evolved to love of humanity. This is the foundation of our approaching great humanity.

The colored coral meadow here nas another fundamental characteristic other than its social unity of life. Again the thought wanders far from these lukewarm waters to yonder distant actual sod on the high mountain. I lie stretched out on the burning blood red carpet of the Alpine rose field, and my hand loosens with its roots one of the bunches of plants. It had bored down quickly through the thin piece of turf. Then it seized on the naked rock—old red slate stone. As I push my Alpine stick into the rock a thin slab peels off from the solid mass. On such fragments of slate there appear strange marks. Shadow-like traces of life are written therein, looking like erased writing: a ribbed mussel-shell, a stalk of a sea-lily (the crinoid). Were these rocks once life? Have they hardened out of life? What relation has this ghost-like life in the rocks of the earth, to the twining Alpine rose that today blossoms a few inches from it? I understand. This is primitive rock.

These few inches of humus represent a space of many million years. Millions of years ago it was stone. Two different worlds touch each other in this space of a hand-breadth: the earth of today, with its Alpine roses, and the stony surface of a primitive earth, that is broken off in the crumbling slate-stone. Many million years must separate us from the life of yonder mussel and sea-lily, but how did the life of that time become embedded in the stone?

The coral-garden is the answer. I grasp bravely to uproot a little bunch of rose-red animal blossoms. Before I have even touched them, something happens which shows me that I am dealing with animals: the flower-tops suddenly disappear into a formless red clump. They have perceived my approach; they are frightened; they close like a sensitive eye before a blow. Yet I recall the mimosa pudica among plants, that closes its green feather-like leaves also of its own initiative, upon being touched. There is no fundamental difference here: it is only as though the Alpine rose had the same sensitiveness which the mimosa and the coral possess. Is sensitiveness then not an acquisition but rather a fundamental characteristic of life? I seize into the soft animal mass and attempt to uproot it. My hand encounters something hard and stone like. In order to loosen a small colony of these flower animals, I must take my

hammer and break off a piece of the rock itself. These coral animals do not cling like the Alpine rose with a root work in a layer of humus that makes but a shallow layer with a sharp break and no transition stage between it and the rock. The corals immediately cover the rock itself with their felt-like colored living mass. Indeed it appears as though the body sent out points of a rosette form directly into the rock itself. I proceed to investigate these facts at once. These little stone stars that penetrate into the flesh of the coral animal from beneath and that appear to give the dead models to which the twining blossom-like forms of this soft body attach themselves, are something wholly different: namely, a product of the living body itself. We have seen how the radiolaria, one-celled gelatinous balls, build up floats out of hard pieces of silica, which they take up from the water as man takes and swallows nourishment. The corals build the hard structure, so to say, from a sort of internal excrement, which by means of the directive power of the living organisms takes on a definite purposeful and highly pleasing form. The coral is not a free swimmer that builds a float. It fastens itself as a polyp to the earth. If it, in a similar manner, is to excrete a firm support for itself, this must take the form of a stool instead of a float, a structure of a supporting and bracing form.

The form of this little stool is, therefore, predetermined, for the coral polyp is not a formless mass of jelly, but a radiated blossom like soft body, with a star-like extended structure. The stool indeed must in general take on this form, without to be sure, exactly reproducing the soft body in the hard parts. So there arise delicate little rosettes. The material of which they are formed is not the silica of the radiolaria, but is mostly calcium carbonate. With this little support of lime the coral animal attaches itself to the primitive rock. These animals pressed co-operatively by millions side to side cover wide fields. At the same time support presses on support forming a compact crust of lime,—like a coat of plaster on the surface of the rock. The surface of the rock itself disappears from view beneath it.

In our efforts to raise a piece of this coral "turf" we find ourselves penetrating below the superficial layer of mortar. However hard the stone beneath may be, still it is not the natural rock. Under the upper layer of lime to which a color is given by the living animals is a second and third layer and so on, masses of lime plainly composed of mortar made by coral animals. The form of the support shows itself clearly. These are old supports, unused, piled in pyramids, upon the uppermost platform of which the living possessors erect rows of supports.

We understand: they are the unoccupied seats of past generations, a kind of pyramid of skulls, and, at the same time the ruin upon which the young life blooms. We bore a deep hole into the mass. It passes through many folded perforated lime arranged in rosettes. Gradually these holes are cut across by boring animals, that create here safe asylums for themselves, worms, sea-urchins, and crabs. The spaces become more and more filled with sand, which the breakers have poured into the holes, or which the worms have brought in in their intestines and have discharged within. At last the union of the supports becomes invisible, the stone draws together into a kind of natural rock, but it remain lime stone. Various indications show to the eye of the scientists that it is a pyramid of these supports, even though the lowest layers have been gradually crushed into formlessness.

We speculate how far this cemented life-derived structure must go down before it reaches primitive rock, before the frame of life reaches the frame of earth. Our glance follows the colored coral turf upwards as it stretches along the slanting hill side. Meanwhile the gentle current of this pleasantly soft warm water seizes us and carries us upward. Suddenly the water is white, breakers foam around us,—and in the next moment the animal meadow is gone,

gone is the blue crystal bell—high above us arches another blue—fixed and immovable. Under its arch stands another picture fanned by the warm tropical wind—an upper surface picture.

This coral circle also girdles, like the sea-weed forest, a strange little island in the ocean. We have come to the surface at its rim. There lies again the boundless heavy dull rolling water surface of the ocean. We recall that it is thousands of feet downward along the coral meadow to the radiolarian abyss in the black deep sea night. From above, as already seen, the sea horizon appears to indicate something of the enormity of the water column in its heavy giant waves and dull color. One feels that this carpet, which possesses the thickness of four miles, requires hundreds of square miles of surface in order to stretch itself properly. The heavy folds of this carpet are the great sea waves, that one after another roll against this island shore, producing a high white foam wreath. This foam wreath engirdles here not the basalt pillars of a volcanic shore. Its steep snow-white mane flutters on a low strand margin almost as white as itself, upon which there lie only a few yellowish white lime stones thrown up by the storm. Lime stone forms its foundation. This island does not rise like a projecting cliff in the ocean, but looks more like the flat head of a rough post sunk al-

most level with the surface of the water, from the crown of which the vertical rays of the tropical sun is scarcely able to drink the water that is thrown up by the highest surf. On this crown, however, and only separated from the white foam by a narrow rim of white lime ledge, there rises in this strange wind-swept place, like the masts of some ship that has existed through the storm, high living structures. From these stiff crooked stems, bent toward and from each other and often twisted in net-like forms, there rise long waving green fans in trembling canopies, against the marine blue of the heavens. These are cocoa palms. They are the plants that have actually succeeded in conquering the realm of the free air. Billions of cells have learned to build in a truer co-operation a yet more artistic web than that of which the giant sea-weed of the ocean was composed. The thin algal stem has hardened into a woody trunk, that remains much softer than the lime bodies of the coral animals and which, by elastically yielding to the frightful storms of the ocean of air which throw themselves with full force against this beach, can maintain itself for many decades.

In the whole structure there still remains something to remind one of the coral polyps of the ocean meadow, and the crinoids of the deep sea bottom. But the giant crown of the palm fan does not angle for nourishment up there in

the air like an animal. Its roots are like boring, sucking mouths in the depths and the stream of nourishment flows upwards instead of downwards. The whole story of the conquest of the land by plant life is made evident to the eye in this majestic palm. It reaches out so near to the water edge that the highest spray wets its base. By means of the water it wanders from island to island. It throws its brown cocoa-nuts directly into the waves. A water-proof layer of oil protects the tender germ of life within for it could not exist in the salt, and thus in its air-filled fiber garment it swims as in a little boat. So the currents carry it to another beach, the surf throws it up and the conquest proceeds further: there also after a few years a row of high green palms wave over the lime margin of the sea, protected by this natural break water from the actual mechanical force of the waves and only watered by the damp sea breath.

When the short twilight of the tropic day has ended in this palm grove, when the sunken sun has been replaced by the mystical light cone of the Zodiac and high in the heavens the star picture of the Southern cross begins to shine mildly—then there creeps out from the holes in the net-work of roots beneath the trees a marvelous gnome population. Like hideous misshapen spiders they go touching around, wrestling busily with the fallen cocoanuts. They

are not spiders, but crabs. They run over the sandy beach. Now one of them has seized a cocoanut. What can he do with such an iron armoured thing that defies the world ocean? Now intelligent work begins. As a human hand would peel an apple, so the great claws of the crab systematically tear off the fiber covering. Then these same heavy claws are used as hammers. They pound on a very definite point on the round nut, on one of the "eyes" through which the germ bores. When the shell finally gives way here, the crab turns around and, inserting one of the thinner rear claws in the opening, joyfully extracts the white fruit-like flesh of the nut piece by piece. The rising moon lights up the scene. Cocoanut-eating crabs on land! Crabs and water—how came these to be separated at all?

As with the plants, so also the animals are drawn on and encouraged to a conquest of the land. The crabs may have first learned to know and value the cocoanut as it floated in the water from island to island. The flat lime ledge of this beach has then encouraged them to go up on the firm land after the cocoanut. The crab was a pure water breather when it came, accustomed to suck the air out of the water by means of wet gills. In the whole higher animal world breathing begins with such gills, with crabs, with mussels and with fish. Even today the

cocoanut crab possesses little gills and can return to the water, but ordinarily he no longer

XII. CRAY-FISH OF THE CLASS CRUSTACEA OF THE PHYLUM ARTHROPODA.

Note that the Crustacea are usually gill-breathing except in the case of land-crabs that have developed lungs.

uses them. In the walls of its gill-slits there are branched blood-vessels that have taken up

the role of lungs, the breathing organs of land animals. These crabs now live in holes in the earth like mice. Only at certain times do they return to their old element: when it is necessary to lay their eggs. The young crabs repeat the history of the race. They breathe water like the polliwog of the frog, which reproduces once more the fish stage. So these land crabs of the palm island teach us the tremendous step which land animals have taken, and at the same time explain the "how" of this step. Along with these crabs there walks a little fish, hopping comically along on its breast fins, climbing at least temporarily upon the palm beach, and crawling into the root work of the mangrove bushes to chase insects. This fish has also in a similar manner permitted its gills to revert and dry up, and has begun to breathe air with the attachment that in the water served as a swim bladder. Thus it is that the true lung develops from the air-filled swimming bladder. The air insect, the light-winged dragon-fly, the beautiful butterfly, have arisen in this way. Their ancestors became the lords of the land in the form of crawling worms such as today are numerous in tropical lands. In these many-jointed, many-legged worms was developed an ingenious system of pipes, the so-called tracheal tubrals for breathing air, and this system has been bequeathed to all the descendants. Manifold the

methods of solving the problem, but only a single goal: the conquest of the land. Even the snail has acquired lungs and climbs upon the palm tree. It seems as though this tree had drawn them all up with itself into the free air: the alga has become a palm, and has drawn the snails, worms, crabs and fishes up out of the water, and accustomed them to the new element.

But how was it that the palm came upon the land, stretched its stem up into the free air and spread its fan? The night has gone again, and the ghostly crab people have disappeared into their holes. The glare of the equatorial sun pours down upon the stirring palm leaves, which the sea breezes move lazily. One looks away between the straight stems, and thinks to see a rising land and blue mountains behind them. But strange, behind the thin palms there lies once more a snow white streak of sandy beach. Then the sun glitters once more upon the water. Quiet and waveless this water lies, like a shallow pond of marvelous emerald green, in which there is only an occasional movement, looking like a violet cloud. A sea so close to the ocean? The palm beach seems merely a narrow sickle between the two. The word sickle is very fitting. The coast bends in, followed by the ocean, enclosing this inner lake in a semi-circle. We look closely. On the further side the thin line of palms closes around this emerald sea. Here and there are

tiny openings into it like doors from the sea to the ocean. This whole island rises like a crater rim out of the wide expanse of the ocean waves. The rim is crowned by the palms. The inner crater is filled with the green sea. Against the hard outer rim the white spray breaks. The crater sea lies peacefully in the lap of this rim with its palm crown

Now, aside from the peculiarly significant form of the whole island, the dazzling whiteness of the rim strikes us. It rises out of the spraying foam as though formed of meerschaum—in every way resembling iron-hardened meerschaum. There lies a single block, torn loose by an exceptionally angry breaker and hurled upon the beach. The broken side shows an open structure like a petrified mass of foam bubbles. But we recognize another writing here, the sign of life. These are the tiny supporting pyramids of dead coral animals. This whole rim of land is nothing more than the work of corals. The coral supports form stone, and tiny fragments of the supports form the white sand. The naked lime skeleton bared of the living flesh produces this dazzling white lime color. It is here that the palms like a race of monstrous parasitical* polyps have established themselves on the skele-

*The word parasitical here is not wholly correct. A parasite lives upon a living organism. The word saprophyte is used to apply to a plant that lives on dead organic matter.—Trans.

ton, as cypresses in a church yard spring from the decaying human corpse. Life maintains itself, here, upon the results of life.

The coral animals have not adjusted themselves to life in the air. No branch of the family has ever been able to do this, not even the medusae, since they are too largely composed of water, being little more than gelatinous sacs in the water. The medusa which the storm throws upon the coast is torn in pieces in a breath—a mere drop of salt water in the sunlight remains. It is clear to be seen what has happened. This white lime beach is nothing else than the highest circle of the great cement mass, that the coral population, on its sloping meadow, has placed beneath itself in the lapse of time. While under the water, this foundation of lime is covered by the youngest generations of the coral animals. On this rim free from water there is no trace of any growing life, but the whole material is the work of life. Even these little supports upon which the palms raise themselves into the free blue of heaven, and into which the land-crabs dig their holes, were all once built a few feet lower in the ocean. At that time the waves passed unchecked over the highest rim of the coral meadow. Sometimes a little foam gathered on the highest places. The mariner who did not heed this significant signal might easily be wrecked on this subterranean "reef." But one

day the rim raised above the tops of the sea-waves, and became the ground, which has been further heightened by pieces of coral lime stone thrown up by the storm. The Alpine storms sometimes seize upon the real meadows with wild hand, and tear out blocks covered with the Alpine roses and hurl them into the valley; here, on the contrary, towering waves constantly tear loose new coral colonies with their supports from below and toss them up on the coast. Sand creeps into the joints, life goes out, and finally the fragments lie above the surface of the sea. However often the breakers may wear the material away, just so often new contributions come to this highest pyramid of skulls. Finally the mortar field of the corals rises out of the water as a permanent hard ridge, while down along the slope below the water there hangs a colored animal meadow blooming joyfully. Now the first floating cocoanuts from distant coasts land. Then the palm forest rises, to which the crabs, coming from some distant beach, flock in their amphibious youthful form. Life has built an island for life. It has not simply conquered the land for itself. It has itself created land in the wilderness of the world ocean—an island of coral lime. We have been told of a silicious alga that by boundless multiplication could build a new earth. That was merely the dream of a possibility. Here we have the actual picture.

Life, sown in the endless ocean, sucks in the tiny particles of lime, that are dissolved in this water column like sugar in tea. The lime absorbed by the corals builds up miles of firm strong islands, upon which palm forests grow green and men can dwell.

Even this does not exhaust the full significance of the picture. The coral, within the water, is a child of light and warmth. It can not go down into the water more than one hundred and twenty feet. Its colored mat does not extend further than that down the steep cliff. Here then must lie the lower limit of its island building. There must then be subterranean sea-cliffs at that depth in order that the corals may build upon it the pyramid that is finally to appear as an actual island. This seems to limit the size somewhat. The island building of the corals is then really but the building of tips, only crownings and completions: it only builds submerged reefs into true islands. But even the lowest outposts of this mat rest still upon coral lime-stone. Downwards in the darkness from it falls the lime-cliff with no sign of the true cliff rock. Is this simply composed of the loose material that has rolled down from above? But this lime is found under the whole life-zone of the coral colony. We sink a hole in this island rim, and bore down past the lowest level of the mat—boring down and down—and still remain in coral

lime-stone. We bore down eleven hundred feet and are still in this pyramid of coral supports. Then we drop a lead outside to ascertain how high the whole coral island rises out of the actual ocean depths and find it to be six thousand feet. If the coral lime-stone extends to that depth, then the coral animals are not simply island, but mountain builders. But how can this be possible when the coral polyp can not live at such depths? The solution begins to dawn upon us. When the corals began to build there was here a real natural cliff reaching to within one hundred and twenty feet of the surface of the water. On this cliff the first generation of corals settled. They deposited upon it their layer of mortar, composed of lime-stone stools, and died; the next generation located itself upon the deserted stools and built supports—and so on. So there grew up to the surface a coral crown. Then a giant hand entered into the play. The old earth moved beneath the whole. The earth colossus is never quiet. The hard rock cliff in the throbbing ocean is only an apparent symbol of the fixed contrasted with the wavering. The view we take depends upon our standard of time. Each hour sees a hundred waves rise and fall in the ocean. If we could observe through hundreds of centuries as we do hours, we would see the crust of the earth, the "fixed," in a similar wave play. Slowly it rises up before us

here and sinks down there. Like water waves the high folds creep up, here building hills and mountains, there forming deep ditches, ravines, valleys and abysses. Enormous quivers, "earthquakes," appear, even where the surface appears free from the never-ceasing mass movements. In the course of a thousand years there are formed deep under the never-ending wave play of the water surface, earth waves, with crests and valleys. Slowly the wave, a rising cliff, falls back, in order to rise anew in some other place. One day this fortune happened to the cliff beneath this coral island. It sank. If this had happened quickly, the coral dome resting upon it would have been at once drowned in the dark water depths. The coral polyps would have died and disappeared. But since it happened slowly it offered an opportunity for a grand race—one of the most marvelous battles of life.

During the time the cliff was sinking the coral generations piled their tiny supports upwards. The lime peaks rose layer upon layer. Now one hundred and fifty feet of old lime structure lay below the life boundary of the coral polyps upon the sinking cliff. Thousands of years passed and passed. The cliff finally went down depressed by the six thousand feet of depth to the level of the ground below. The pyramid of coral lime once only one hundred and fifty feet high is now fully six thousand feet high. But

the coral life itself blooms only within the limits of the one hundred and twenty feet below the surface. In the whole six thousand feet below lie the lime structures of the unnumbered dead generations formerly housed in them, the immense place of skulls of the poor never-resting workers that with their hard bone material built up a long ladder for their successors. A triumph of life without an equal!

And yet this is not all. The fine crescent form of the coral island, that like a white ring encircles the emerald lake, is significant. The cliff on which the corals originally began to build was in truth no solitary projecting rock. What in reality jutted out of this place during primitive times was a great island. Mountains lay in its midst, from which springs ran down to the beach. From this beach, however, the platform fell away in steep stages to the abyss. The one hundred and twenty foot stage was the level on which the corals began to settle and to build their "cliff." Naturally, this stage ran around the entire island, and therefore the coral colony from the beginning took on the form of a circle around the island—an encompassing ring. Upon this level they erected within this circle their first wall, up to the surface of the water. Gradually they raised a battlement of lime a little less than one hundred and twenty feet high around the entire island. Only at a few places

did they leave an opening through this battlement: namely, where the fresh water brooks ran down to the sea, thus stopping their work.* Now, however, began the sinking—the subsidence of the entire island. The foundation stage sank—so the battlement was raised. At a certain time the whole island with all its mountains disappeared from sight. In the central space inclosed by the battlement, a lake took the place of the drowned island, a lake into which the sea water streamed through all the old gates in the walled circle. The corals could then have built within this lake, but they preferred the external side with the breakers and disdained to locate the sloping meadows within the peaceful pond. As time passed this pond grew deeper, like a crater within the coral ring. The old battlement remained standing a conqueror that continued to assert the old circular form, like a mathematical circle, from which the contents had long been lost. The island lay beneath, the coral ring lived and raised, life has saved its island, in spite of all the powers of the earth.

We came upon the shell-fish in the rocks under the Alpine roses. We can imagine now that, through one of the incalculable changes of the

*The coral polyp requires water less than one hundred and twenty feet deep, with a temperature about 68° Fahr. The water must be clear, salt and not too quiet.—Trans.

planet, the whole sea suddenly disappears, drawn off to other regions of the earth, and that we wander below on the dry surface of the present ocean abyss. This coral island would then rise above us, an actual giant mountain. Mist clouds would hang about its peak. Weathered by air and water its sides would betray externally scarce anything of the coral origin. Debris from the weathering would build heaps on its flanks. The living coral mat would immediately perish with the first drying-up of the water. On the lime declivity in the sunlight actual flower fields would establish themselves and red umbels nod over the old blocks. I dig up the plant humus in such a place, break loose a piece of the rock which is in truth old "life rock." A trace of the rosette-like figures of the former coral structure appears yet. A shell fish which once lived in a cavity of the coral structure falls out of a gap in the rock. It is chalky white now from age, like the weathered coral mortar itself.

My thoughts turn from this back to the actual picture.

Was the "natural rock" that today lies under the blue Alpen glacier once such living rock, such coral rock.....?

I reflect on the many millions of years of the history of life on the earth. I question whether life that makes new islands rise out of the sea,

that preserves the form of sunken islands like wax maintains the form of a coin, has not the power in the course of millions of years to build whole mountains?

We rise out of the water into the light. Now we will go to the islands of stone and penetrate into their depths, where only the miner goes, and enter in even deeper than he. Very well; we proceed into the depths. The rocks open up before us even as the water with its nine hundred atmospheres of pressure gave way before us. We pass through the coral layers mixed with floating sand, through shallow strata into the timber work of the mine which penetrates into the foundation of the earth. At six thousand feet we come to the last depth that man has reached by boring. We have left the coral cliff, the "living rock," behind us, and are in the original rock. There rise around us in enormous square the stiffened waves of a stone ocean. Indeed there is much that looks like the work of waves; the strata are bent, swollen, often regularly rolled up and slipped over one another. We can imagine how the crust of the earth writhed in its hidden depths, how it pressed the hard stone until it became plastic; a silent titanic work whose power still occasionally quivers above in earthquakes that overturn human cities like card houses. In these twistings and bendings of the layers thousands of feet below the surface

lies the real force that produces the lifting and sinking, which permits the cliff beneath the coral colony to slowly sink and just as slowly raises the coast in other places.

While for a short time we follow the strangely bent horizontal folds, we feel the rapid increase of the warmth of the earth. We have left the cooling influence of the ocean, and have penetrated into one of the very foundations of the main land, as into a colossal mountain. The same thing that arises whenever a tunnel is built shows itself here in a higher degree: it is increasingly hot. Now great perpendicular folds break through the horizontal blocks. Streams of water rush through the invisible crevices in the grave-like night. We touch such a spring; it is boiling hot. Amid these transposed crevices the lava lurks in gigantic bowls, and in subterranean seas hollowed out of the rock, bursting forth in destructive glow as soon as the pressure shall be somewhat lessened. What has life to do with such an abyss? Fables tell of frightful fire genii banished by the hand of the gods to these depths and imprisoned by the weight of the masses of stone. This significant picture is justified by a glance into a volcano. Truly there is a primitive giant imprisoned beneath the weight of these miles of stone: the sun stage of the globe, the flaming age lies enchained with fetters of granite. When this flame still covered

the whole surface, and the earth star was a star among stars, glowing like a sun—the delicate foam substance of life could certainly not have existed. When in later ages boiling basalt floods were poured over wide surfaces life would have been destroyed like a piece of human flesh touched with a drop of molten metal.

Suddenly a dim light is seen. The stone separates in a great opening. Cool air as from a cellar strikes our heads. Before us lies in dim outline a monstrous cave. Like the grotesque teeth of some gigantic monster the stalactites hang down from the roof and the stalagmites rise from the floor. Dripping water taps and patters gently. This is the craftsman at work which in thousands of years has hollowed out this whole cavity in the white lime stone and deposited the particles of lime in the stalactites and stalagmites. The arches of this cave rise to such a height that its upper galleries touch the day light through open crevices, while the lowest are yet in eternal earth night. Perhaps just above is the tropical forest. Palms and lianas press into the crevices between the strata. In the crevices nearest to the light sound the shrill cries of millions of great owls that have their nesting places there and only leave the cave for their ghostly flights in the moonlight. We do not turn our steps in that direction, but descend into the lowest black gallery. As from Charon's

boat, so our torch glows above a subterranean stream whose surface has never yet reflected the sun. The night birds do not penetrate to here. Here appears to be the actual kingdom of death.

The testing hand touches the cold wall of stone above the black water. A fine white dust adheres to it. The whole rock is baked out of such dust. The "natural rock" upon which the coral pyramid builds itself is composed of this dust. It is chalk dust. The walls of this cave are of chalk stone. Every sinking island in the ocean is composed of chalk stone. White writing chalk. I think of a beautiful picture up there in the sun. Imagine, steep snow white walls to which the sea clings at the bottom, while above an emerald green crown of birch forest lies near the rim. I think of the first view of the English coasts at Dover. There are such white cliffs, cut perpendicularly to the breaking sea and crowned with green meadows.

In these depths I use once more the apparatus used in the deep sea investigation. I carefully illuminate and magnify a little of the white dust clinging to my hand. As in the sample of the deep sea slime which showed us the beautiful radiolaria, so here in the magnified chalk grains there are marvelous art forms. With them the story of the white chalk is suddenly unfolded to us.

Here are delicate forms, some resembling ar-

ticles of human craftsmanship, some the shells of snails, of the nautilus, all so very small, however, as to be distinguishable only under the microscope, but all inscribed with the mystic characters of life. Once more they are the chambered houses, boats and balancing apparatus of primitive one-celled animals. These tiny animal houses are not built of silica this time. This chalk is a lime-stone. In order to form it the animals must secrete lime. We know such little lime-makers today. They tumble about in innumerable swarms in the same water column of the ocean where the radiolaria swim. We call them foraminifera. Through a process, still in many ways puzzling they draw the lime out of the sea-water and force it into the beautiful art forms of their little houses. From these moving swarms a ceaseless rain of dead empty lime houses falls into the peaceful refuge of the sea-depths, heaping themselves ever higher. So tiny is each individual that there are fifty thousand shells in one gram of this sand. This continuous rain has covered eighty million square miles of the ocean bottom with foraminiferal ooze. Further eighty-two million square miles would be covered with the same sort of lime blanket if it were not for the fact that it is so deep that the free carbonic acid gas concentrated by the water pressure dissolves the lime shells like sugar in coffee and thereby dissipates the lime. In this

field the silicious shells of the radiolaria with their greater resistance alone maintain themselves. Eighty million square miles are very close to one-fourth of the total surface of our planet. On one-fourth of the earth's surface, then, there falls continuously a rain of this fine lime snow of which every crystal is a life product that does not dissolve, while upon another quarter it falls only to be continuously dissolved. Hour after hour, day after day, while years, centuries and thousands of years go on never wearying, never exhausted, this silent rain of organized lime particles goes down into the sea. This monstrous ocean five and a half miles deep produces a cloud of these tiny crystal balls. Every second there is enough of this sulphuric acid lime or gypsum particles dissolved to form a mass of one thousand and fifty cubic miles when transformed through the labor of life into carbonic acid gas lime. That means that this drizzling snow fall could build up a lime mountain four miles high, four miles at the base and eight thousand, four hundred miles long, that is, as long as the whole Cordilleran range of America.

This supply of material continues constantly, no matter how much is taken from it, like a permanently rising fog that ever creates new snow clouds.

To be sure, seconds are not enough to give

to life the power to suddenly construct th
mountain of chalk. But we think of the cor
reef. To life is added the unconquerable assis
ance of time. Profound was the myth and fu
of meaning that painted Chronos, the god o
time, with an hour glass filled with sand. Give
the millions upon millions of years of time an
out of the sand glass these snow flakes of th
foraminifera will pour forth continuously ov
a quarter of the surface of the earth, until a
last those giant chalk mountains the Cordillera
extend out of the previous ocean depths an
plateaus of Gaurisankar height rise above th
ocean surface.

What the coral accomplishes in the confine
space of the circle surrounding the island th
forming of rock by a deposit of a layer of mo
tar of stone-like cement—that the million yea
of continuous fall of dust composed of anima
lime flakes does. It forms an enormous cemen
column of mountain height, which like a meta
band lies over one-fourth of the total surfac
of the planet. Indeed, with the changes tha
have taken place in the ocean bottom during th
lapse of geological ages on this planet the whol
surface has finally been covered with a crust o
lime snow.

Once more we are not dreaming. Our han
that is here grasping the rock foundation of th
earth in touching this lime crust of the plane

touches the lime crust of life. It is not uniform. What is there that could remain uniform in the stone garment of this savage Titan! We have seen how it throws its cloak into folds, bores holes through it, tears it, tosses it into heaps. As it has pushed the ocean aside it has torn up its lime foundation. It has forced it out into the open air where wind and frost and water gnaw it in pieces, crush it and pulverize it into dust, to be once more drunk up by the water. It is thrown up into the lap of the earth, covered with masses of sand and gushing lava until only the miner can discover it. Wherever we study the earth, there it appears to us in enormous masses, even in the fragmentary forms. Not once only has this lime plaster of life been spread over the surface of the earth. During every age in the history of the earth, each with its millions of years, it has been built up once, twice, thrice. The ruins of each of these layers lie tilted as the earth giant has stretched and pulled, sunk and rose again, and hurled them about now high in the air, now deep down in the dark abysses of the earth. Millions of years before yonder coral structure began its life work, that "natural rock" arose, itself a foraminiferal covering for the ocean bottom—a work of life. In the same period arose, in that same primitive world ocean, that lime cliff which today lies beneath the Alpine roses on the mountain heights,

and which still contains mussels and sea-anemones as proof of its oceanic origin. At the same period these places at the bottom of the deep cavern were also beneath the ocean, with the lime layer already piled up mountain thick. All of these little animal coverings found here in the rock were once a part of actual living beings, swimming around in the ocean. They were laid down millions of years ago in the lime layer and now as broken fragments of that layer are buried in this dark abyss where the water has gnawed out these mighty stalactite hollows.

Do you hear the drops slowly falling down these stalactites? It is the ticking of the century clock. From this we can construct an instrument that shall be to time what the microscope is to dimension, and in whose illumination we shall see, not an enlarged chalk scale, but a landscape of grotesque majesty.

The old Paleozoic age arises with all its exaggerated marvels.

The warm sun paints a silver plate in a wide blue ocean. This water column rests on a deep slime carpet that is today the white chalk of Rügen. The waves lap on the shore, and mix with the fresh water, and take on a dirty yellow color from the suspended sediment, like the Mediterranean water at the delta of the Nile. But the giant stream that rushes down from yonder blue mountains to the ocean, comes from

beyond Bohemia, and the sand-bars that it built at its delta, today constitute the boulders of the Alps. The silver glance of the sun in the blue ocean shone upon what is now the level North German lowlands. Over in the Western Hemisphere the ocean wandered over endless tracts of North America, until the surface of the water was dammed by low flat hills, where today the prairie is broken by the girdle of pine trees about the high mountains. Through this mighty ocean swam monstrous reptiles with snake-like heads, whose throats opened like giant gates, and with long thin bodies a hundred feet long. On the cliffs along the edge of the shores sat, in thick rows after the manner of the penguin, the great kingly bird of the west, six feet long. Like the penguin it was unable to fly. Instead of a bill it possessed jaws, out of which sixty-six sharp crocodile teeth projected. Behind it was provided with a thick, beaver-like tail. Perhaps the flock raised a donkey cry like the penguin, but at the same time there was mixed with it another sound more like the snorting and spitting of true reptiles. Over the water surface moved a horrible dragon shadow, flying like a gigantic swallow. The wings measured twenty feet when extended, but they were not covered with feathers. Instead lizard-like colors glisten on the hide. As it approaches the horror of the dragon dissolves itself into a droll picture. The

great expanse of skin recalls the colored paper dragons of our childhood. Between its extended plates, which form a truly wonderful example of a flying machine of feather weight, there hangs a tiny body with dwarfish deformed hind legs and an insignificant nut-cracker head, the absolutely toothless jaws of which can only snap but can not bite. These were of the species of the "toothless flyers," reptiles of the pterodactyl that for a time drove out all birds in the kingdom of the air.

Now the kiss of the hot sun touches the land. "All sorts of dragons dwell within the caves." Upon the light field of our cave wall there crawl the hideous forms of dragons. These are colossal forms of animals reaching thirty feet high as they stand upon the hind legs, and waddle about the shore of these inner seas. Every step stamped a giant three-pointed track in the quivering slime. The swaying stomach hanging down recalled a fatted goose. An enormous flat crocodile tail behind maintained the balance. High up in the air on the curved neck hung a camel-like head with a parrot bill reaching out beyond the two jaws. The arms were short but every thumb was a dagger that could bore through any opponent, who might be seized with the ferocity of that old feudal instrument of murder, the "iron maiden." What sort of a howl may have proceeded from the mouths of

such animals, what sort of stench they may have sent forth into the air from their breath, how in anger their heads may have glittered, blue, scarlet, sulphur, red, and how their crocodile tails may have dealt out blows that would have split the stems of palm trees and hurled the muddy slime into heaps! But even this thirty-foot giant, the iguanodon, suddenly began to hop away like a kangaroo in a hasty trot when the atlantosaur appeared, a boa contrictor one hundred and fifteen feet long that could swallow an elephant, as we are told in the legendary zoology of the old Pliny. The little snake-like head hangs in front and the long thin tail drags out behind, but in the middle in the neighborhood of the stomach the body swells to the size of a Heidelburg casque. Under this casque-like portion of the boa there are four stools, much more like the supports that we set under a mounted snake in the museum than true legs. Each upper thigh of these legs is six feet long. While this hideous machine slowly strides along we can scarcely conceive how it is possible for it to move such a great whale-like mass on these thighs six feet long. Certainly that tiny bird-like head that hangs upon the neck, not like a head but rather like the tip to a tail, appears absolutely incapable of ruling this bulky body at such a distance. So we learn that in this dragon the fundamental law of all vertebral develop-

ment has been absolutely turned upside down. The vertebrates reached the height of their development by the construction throughout the length of their bodies, dorsal to their stomach, of a long channel in which all nerves are united, and where all the high central stages were knotted together and where the final sensations all led to the foremost portion, the brain. This form has arisen slowly from the river lamprey beneath, and reaches its triumph in the man, who, when I pinch any portion of his whole body, will at once sound an alarm up above in the skull capsule and set in motion the necessary protective activities. With the atlantosaur, however, the brain up ahead is utterly incapable of use as a central station for guiding the land transportation of a body weighing sixty thousand pounds; consequently it is necessary to have a main central station in the vicinity of the body. Here where the spinal marrow increases to three-fold and, indeed, in some forms to ten-fold the thickness of the brain, there is formed a "tail brain," and this not simply as an assistant, but as an independent central station. The whole "thought" that controlled the movement of this wandering Heidelburg casque was performed in this rear spinal ganglia, while the true brain had perhaps no further purpose assigned to it than to function as a seeing, hearing and smelling apparatus, which in the tiny head of

the dragon body hanging down like a snout, might be compared to the illuminated berry on the feeler of the deep sea fish.

Slowly this giant moves on. To be sure that problem is solved! He can move. But how deep his thick, rhinoceros hoof sinks into the soft strand at every step. Woe to him if the face of the ground betrays him. His sixty thousand pounds must sink down hopeless like a leaky ship of thirty tons into the yawning abyss of the ocean. But even aside from this another obstacle gradually appears. The sun has risen to the zenith and sinks with its burning glow. It lies like a hot breath over this whole period, hot even in the lands where it is today much cooler.* Here we touch once more upon the secrets of the heavens and the earth, which our knowledge is not yet ripe enough to solve. In this glow it is as though the oil in the wheels of this giant living machine were evaporated. In such reptiles the temperature is not ordinarily regulated by the blood, which possesses no constant inherent warmth, as with us. The temperature of its blood rises and falls exactly to correspond to the outside temperature. This growing heat raises the blood to a glow, but this glow sinks gradually into the mechanism of the whole. Lazy, benumbed, the giant lies in a heat rigor like a motionless land tortoise in the dust

*Corals once grew in Greenland.—Trans.

of the street which will lie and let itself be roasted until its shell is too hot to touch, and thereby becomes so phlegmatic that a wagon wheel can roll over it without causing it to move. And so it was that here and there one of these giants survived through a special development of its sluggishness. These were the ones that were protected by crocodile-like shields of bone. Some of these were dotted over with spurs covering the whole shoulders like a hedgehog, with the exception that these hedgehog quills had here become long razor-like swords. Yet another carried along a corresponding comb, the teeth of which were not made from its hide, however, but were solid pyramids of bone. No lion-like beast of prey of this time dared to leap upon this comb, since it would have been miserably pierced and sliced by these movable plates when the tail brain should set them moving to and fro. Hence it was without enemies in its sunny laziness!

Finally the sun went down. Then came the thick, cool, embracing night. Now, however, the heat of the machine began on the contrary to go out, the temperature of the blood sank to agree with the fall of the thermometer in the air, and once more the mental energies of this hideous machine sank, weak and heavy.

In our still cave new great truths of life have passed before the magic picture of our ap-

paratus! Life has placed animals upon the land. It has sifted out of all its wealth of experiments the highly-centralized stage of the spinal marrow and vertebral animal as the best adapted to land conditions. While the other land experiments in the animal kingdom did not exceed certain very small sizes—among the longest of which were a few earthworms, none remain save the very beginnings of the insects and spiders, and the land snails—with the vertebrates for the first time, life was fortunate enough to rise to a mass in size such as was formerly possible only in the water. In the ocean the vertebrates, even in primitive times, had reached the size of the giant shark. Descendants of such sharks have crept like monster fishes upon the shores, have developed four legs, and with the neck loosely jointed to the trunk have raised the head free. So at last the reptile type, the primitive form of the lizard, arose. These lizards boldly took the great mass of the sharks out upon terra firma. Indeed, they exceeded all animals that had previously existed of this form. They rose to the size of moving houses. We must consider the difference in the elements. How the fish with its perfect form can shoot through the water, a creature for which gravity has been completely abolished. Now, however, the problem arose of how to balance a body one hundred and fifteen feet long on legs and to move it over the

earth against which, in the free air, every point presses with its whole weight! The solution was obtained only at the cost of the centralization of the brain into a, for other purposes, senseless, and in a true sense a "retrogressive" tail brain. But it was not so fortunate in its permanent regulation of the heating of this giant machine. To be sure it was through the experiment of the vertebrates that this regulation was fortunately obtained in land animals. We ourselves possess it, as all mammals and birds have it. With them the warmth of the blood is independent of the external temperature and remains at a fixed point in all changes, like an eternally self-regulated stove. In one way this had already been attained; indeed, it was attained in the midst of the age of reptiles, but only with little animals, the first tiny suggestion of mammals and birds. How like an invention that is favorably expressed in a little model! With it came progress—at that time only with the very small. It was only later that the mammals arose from these smallest forms to the elephant on the land and in the water to the whale. But at that time the colossal reptiles had not attained the sacred fire of the new internal sun. During an exceedingly long period of external sun they vegetated like unconquerable feudal lords, but meanwhile the real possessor, the thinking brain, lay in the lazy hide. Then they broke down, incapable of

meeting the demands of a new period. Three million years at least separate us from their kingdom. Today not a single one lives. Only their bones lie deep in the stone, indestructible as the ancient pyramids on the border of the desert, along side of which a whole civilization has long since sunk into the sand. A tragic melody sounds softly through the rock. It is not alone in the skull heap of myriad individuals that life has planted its conquering banners. Whole races, species, orders of creatures, peoples and kingdoms of the animal and plant world it has devoured within itself. It has built up colossal structures only to relentlessly dissolve them again, because they have contained defects, and it has, with the pitiless courage of the experimenter, permitted a pigmy race to triumph over the great because in it this defect was avoided.

The bones lie in the depths of the earth and the old ocean slime is hard rock. Like an army of eternally active moles the tiny drops of water penetrate into the spaces of these rocks and hollow out wide grottoes. On the arches above, however, there rages a never-ending struggle between the beings for space. The same power that has driven the population of the fishes and crabs into the blackness of the deep sea and the mole into the soft earth loam makes a welcome asylum of the yawning space within this dark horrible cave on the border of the upper

world. We throw a light on the roof of the grotto, on the damp cold wall of this monstrous stone sarcophagus in which the myriads of sun-seeking animals of the chalk ocean and giant reptiles sleep. Among the stalactites there moves a young and actual life. There are animals here again that have wandered into fixed abodes, a race of strange cave animals. Something crawls up the glittering chalk tip of the stalactite which comes down to us like a great root that has bored itself through the roof. It moves round like a ball-shaped, stiffened, red, glittering drop of wax. Long thin legs and great feelers go out spider-like in a star around it. It is leptoderus, the blind beetle of the Adelsberg grotto. Six thousand feet from the entrance it flits around on the stalagmites and stalactites, which are one hundred and twenty-five feet long in the so-called Calvary mountain. It is wingless and eyeless. What should it do with eyes in this eternal night? Nevertheless, it flits like lightning away from the glow of our lanterns. Through some one of its senses it is able to quickly perceive our approach, although it very certainly can not see us. Perhaps it feels the wave of warmth that comes with us, perhaps it smells us with its fine organs on the tips of its feelers. It must be armed with some such power of perception of a hostile approach in its stygian darkness, for on the same damp smooth

wall of the stone root work there trots through the night a fearful enemy of its kind—the ivory spider. It has itself, as a child of the night, dispensed with its seeing apparatus, even to the extent of the disappearance of the whole optical nerve, but it touches and perceives sharply. An encounter with this spider means the destruction of the leptoderus. Sixty-eight forms of beetles alone are found in this chalk cave of the mountains. In addition there is a colorless cave snake, twenty different kinds of spiders, four thousand-legged worms and many orthopterous insects.* Through the black water, which forms a wide branching subterranean net-work of true Hades-like streams, there swims the blind salamander, flesh colored and like a great human finger that of itself beckons ghostly to us. In the horrible seas of the North American mammoth cave live blind fish and blind crabs, and on the dark shores dwell blind grass-hoppers. Many times an accident has brought us sudden news of these concealed existences, deep under our feet, where no one dreamed of them. The raging Cotopaxi volcano threw out with sudden violence, amid the boiling slime, great masses of dead shad, as a sign that it had sucked out and emptied subterranean reservoirs. When artesian wells have been bored in North America, hith-

*Insects having wing covers of a uniform texture throughout, that generally overlap at the top when shut and under which are the true wings which fold longitudinally like a fan.—Trans.

erto unknown blind salamanders of the same race as the one referred to above have burst out along with the water from the depths.

Fungus threads hang from the cave walls, which in spite of their unquestionable plant nature, now as parasites no longer require the light of the sun, like the earth boring truffle, the mole among the plants. Like a portion of the deep sea animals, so here these nourish themselves from the dead vegetable remains of wood and humus particles, on microscopic diatomes, that accidentally creep through the trickling water into the cave and they themselves create in turn the colorless meadow upon which the herbiverous cave animals feed. They lead a silent existence, amid the ticking of countless water clocks, deep in the sarcophagus of a light boasting past—but with all the joys and sorrows of a life that has triumphed over the dead.

A moment suffices us to reach the light from this confines of Tartarus and its living ghosts. We press upwards through a dimly-lighted shaft. The eye turns backward into the gloom as into an eternal starless night. Even in this night there suddenly appears something like a soft green glow, flames flash across our yearning downward glance. Now they are gone; there they come again. Has this cave, like the deep sea, its illuminating animals? But we notice that the light flames themselves, this time,

do not move. They shine steadily, sitting upon jagged points turned toward light openings. Their appearance and disappearance is due to ourselves. If we bring our head between the light of day and the cave flames they suddenly go out; our own shadow appears to destroy them. We turn our head and there they are again. It can not be any spontaneous force of light, but a reflected glow. Something glitters beneath in the faint twilight, but marvelous! The cave walls themselves reflect nothing; they are all dark. Something must be hanging there that has the peculiar gift of seizing the scanty light and reflecting it back clearly. There must be a green body sharing in the process. It can not possibly be merely glittering drops of water. We climb up a little space and grasp at the spot. On the jutting point of stones there lies wet, sticky earth. Fine threads are spun through it. We recognize them as a primitive form of moss. Our magnifying apparatus soon uncovers the marvel. These little moss plants bear, like fruit on a twig, a number of peculiar cells. These cells do not confine themselves to the simple colors of customary fruit. They glitter like the artificial glass fruit of the Christmas tree. Each one of them is indeed very much like a tiny glass balloon, so transparent is its fine living cell stuff. They break up the soft light that falls upon them, turn it aside and focus it upon the

hollow side of their ball, compressing it togethe into a single point of light. Thus the genera dim light mass is transformed into one strikin point. At this point we find in the otherwis crystal clear ball, an opaque spot which glitter emerald green in the light which falls upon i and partially streams through it. From the re flection of this green point of light arises th illumination of the little flames that we perceiv in the shaft. It naturally disappears ever time we cut off the twilight with our shadow for without this diffused shining the little mos ball can not sift out its ray of brilliant light.

The apparatus is so skillful that it must cer tainly have some purpose. All of the cell group are adjusted so exactly that the green spot, un der all conditions, receives the concentrated shin ing light. We can see in the glaring reflectio how much stronger this concentrated focuse light illuminates than does the otherwise un versal twilight of the cave. Where, howeve so much light is reflected there must certainl be much more absorbed. This one little spot o green and the arrangement of an especial ligh trap must have some purpose for the litt young moss plant in the cleft. The green colo quickly directs us along the right way. Whe ever this color produced by the so-called gree chlorophyl appears in living plants there w know at once that it is a kitchen, where the plan

does its cooking. It is only here that it knows how to mix together the proper elements to replace its living substance, to nourish itself, to feed itself and to cook its own soup. The green leaf, the sign of plant life, over the whole world everywhere indicates this stew kettle. But something else is necessary for this cooking. We have already seen what this is when we went down in the ocean:—light. Only in the light can the green soup kettles of all plants do their cooking. Now then this little moss plant lives close on the last border of light. The glow of the heavens has become only a weak gift like a pale fog strewn through the cave mouth. So each of its green stew kettles is concentrated in one point. About this point it has placed a burning glass, a light trap, which illuminates the point with a concentrated extract of the pale cave light. Just as there are plants which catch insects by skillful apparatus in order to nourish themselves, so we see here a light trapping plant. It has been called illuminated moss. Light catching moss would be a better name, for the illumination, resulting from the reflection of a superficial portion of the captured light, and making it appear to the observer that the plant illuminates itself, is incidental to its purpose and is only a secondary matter. It shines only as the eye of a cat glows ghostly in the half darkness. The cat's eye also is such

a light trap. In it also we find the living gla
globe that concentrates the weak light that fal
into it in the twilight into a strong glow in th
interior and when this glow is partially reflecte
we see from outside the frightful appearan
as if the retina itself glowed with a phosphore
cent light of its own.

This comparison leads our thoughts to wa
der, dreaming, far away. With marvelous rin
ing we hear again the great melody of the tota
ity of life. Even in the cat's eye light is ca
tured, but it is not captured as in the plant
order to cook. The animal can not cook wi
light in the sense of the plant. He can n
do it for he does not need to. The plants co
for their own nourishment. The corn that t
plants create in the light is eaten by the mou
and in turn by the cat. Because this is so t
animal has long ago forgotten this method
cooking, it has relinquished it to the plants. W
sit quietly in the home and the corn cooks
the sun for us also. The animal eye does not ha
its apparatus, either, in order to strengthen
own source of illumination from within towar
the outer world, as does the deep sea fish wi
its reflector. It captures light simply in orc
to see. It is not its kitchen that stands behi
its light capturing glass globe, but its sen
tion, its intelligence. The illuminated moss
the cave cleft invented its apparatus in its l

struggle as a help in a desperate situation. In the protected cleft it found a safe spot. Now, however, it could not secure enough light there in order to do its cooking. So the light trap came into operation. The eye of the cat also lies in a cave for its protection, in the shaft of the great skull cave. In the skull it is wholly dark. The light trap leads the rays of the sun to the retina in the shaft, but what the plants found a necessity only for a single occasion becomes to the animal an endless increase of his whole capacity for existence. With this eye the eagle as he floats like a point in the blue rules over all that falls within his vision. The eye has first opened to the individual great possibilities. Consider for a moment the feeling of touch of the largest animal. Then think of the eye that touches the sun itself and reaches out billions of miles beyond the realm of the earth into the world space. With the eye man has looked upon the stars! It is the eye that has spurred life on to an annihilation of space such as no blind touch has ever thought of. By means of the eye the reptile long ago passed through the air from tree to tree, first by springs, then by flight, until it became a bird. By means of the eye man could first sail over the ocean. Then came the ships. Today he wanders with the eye anxiously, yearningly from planet to planet.

The ideal organ, the ideal of a creative organ conquering all great distances, is the eye. Therefore it belongs to the animal, to the freely moving half of the life creations. When man made tools after the model of his organs he made them first of all to obtain actual movements, real bridges to the things that his eye had long seen. He actually climbed with great labor over the mountain which his glance had clambered up in a single second, he sailed over the stream whose further shore he saw. Then came the second and the higher stage: he improved with mechanical technique the light trap itself, placed new artificial lens in front of the natural one of the eye—he invented the microscope, and the telescope. Now he could see the cells whose many millions built up himself as well as the whole solar system and the far reaching distances of the heavens to far away Sirius.* Within these spaces again his cosmical pictures grew and with them his inner philosophy, his ethical conquest of things. So upon this little particle of retina behind the light trap there is cooking the highest material of our world just as the plant within its clean chlorophyl kettle has cooked the lower,—here in the latter the bodily nourishment, there the intellectual.

The cave cleft has closed again. We are

*The so-called dog-star.—Trans.

once more in the dark abyss but it can not remain dark before such spectacles. The eye of the mind still wanders like a great light trap over all.

Ever narrower, ever lower becomes the catacomb-like cave passage through which we are now going. Soon the roof presses down until we must creep upon all fours. Then I suddenly cut my hand upon a sharp edge. From where could a fragment of glass come? We strike a light and discover it is a wholly different material, it is a piece of flint, whose ragged edge has wounded me. It lies close to where it has been broken off. In the limestone itself there are dark strata of such flint interspersed. They must have a still more primitive relation to the old ocean slime than had the chalk. Flint is composed of silica. We think of those layers of radiolaria on the bottom of the present ocean and how these little radiolarian stars consist of pure silica. Perhaps these ancient fragments of silica in the chalk ocean are really hard baked masses of such radiolarian material mixed with countless pulverized silicious skeleton of certain sponges. The crushing hand of time which has pressed the chalk slime into white lime has formed this silicious inheritance from the primitive world life into flint which now penetrates through the chalk in strata, like dried flowers in the leaves of an old book.

And yet as the eye goes over this ancient evidence of life, that life that has turned to stone, there suddenly appears upon this stone a mysterious writing, a strange form: the signature of a second life. The toothed edge that has cut my hand is no natural fracture. This stone here on the floor of the cave strata has not simply been washed down from its natural rock, it has been carefully worked out, it has been purposely formed into a sort of rough knife. Some hand must have assisted here. Whose hand? Even the fractured places are browned with age. If the stone itself is originally three million years old even this work is no longer young, but how old can it be?

In the flickering glow of the lamp, the glance goes over the wall seeking a spot from whence the flint was broken out. Then there appears something strange before us. On the smooth surface something is painted like a giant figure, an animal picture six feet high. The sketch is scratched deep into the rock and then painted out with manganese black and its details printed with brownish ochre. It is the sketch of a long haired elephant with giant tusks. It is an elephant of a primitive world such as has not existed upon this earth for a long period. Its primitive world, to be sure, does not reach back to the dragon days of the dinosaur, but it reaches much further back than any of our

historical conditions, into that great nebulous time from which no voice sounds down to us. Since that time this cave wall has remained untouched, since that time that rough knife like tool of flint has remained here. Like the myth of the beard of the old Kaiser, that grew through the stone table in Kyffhauser and like the stalactites formed particle by particle, the forming of which mark the ticking of the clock of time, so the falling water drops have gradually covered the picture with a stone crust,—so long has it been here. Who has painted that picture?

Some being has certainly done it with a hand that was capable of grasping a tool for sketching and painting. This creature must have been contemporary with the mammoth. He must have come into this cave with the picture in his brain to which his hand gave these lines. Perhaps he had fought with a mammoth itself with this flint knife outside and now sketched the picture with the same knife. But the cave is dark. An eye must have been active in such painting. Then this being must have had the gift of creating light and that in a place where no illuminating moss is capable of creating light. Why should this being crawl back into this abyss? Why did he stay here so long inactive that he found time and inclination to people the walls with giant animal pictures? Did

the struggle for existence, the widely reaching battle of life for room drive him in here like the blind cave crickets and salamanders?

But it could not have remained constantly shut up in here like this. The mental picture of the mammoth must have been obtained outside. I recall those animals who only bury themselves at certain times in deep, dark hollows in the earth like the marmot of the high mountain. It is the winter that drives it into the caves where it sleeps long months while outside the snow piles up mountain high. This mammoth here bears, unlike the present elephant of the tropics, a heavy coat of wool like a polar musk-ox or bear. That signifies a hard winter at that time. Then that being might well have crept deeper and deeper into the narrow throat of the cave to escape the raging snow storm outside. There he has dreamed away a half year like the marmot. But it could not lie down in a hibernating sleep for so long, like the marmot it has painted these pictures on the wall. How has it overcome the cold that certainly must have crept devouringly even in here so that strength and desire remained to pass away time with the practice of art.

In the stalactite roof there in the corner there is a partially loosened broken bone, ancient as everything here. It appears to be artificially split and the split edges are perceptibly black

ened. Blackened by fire? At once my mind composes the picture.

When I strike two pieces of this flint together a clear spark springs out. That being which could chip out knives from flint had learned to kindle a fire with those sparks. At this fire it warmed itself in the cave so that its blood remained warm instead of cooling down like that of the stiffened marmot during its winter sleep. Along with the blood, however, his mind remained fresh, his hand movable. In the cozy warmth of his hearth fire he could paint, to break up the monotony of his existence by bringing before him in fancy the summer with its green pastures over which the mammoth trotted. The red glow of flickering flames glistened on the fresh painting. Now I know from where the light came. This being did not need to shine himself like a deep sea fish, the hearth fire illuminated his cave night for him.

How vivid becomes the picture in this Tartarian abyss. Can you hear the storm howling outside? Here no breath bends the kindly flickering red flame. This being did not need to get rid of any of his organs in order to adjust himself to the cave. He did not need to lose his eye like the blind cave cricket, nor to have the warmth of his blood squeezed out like the marmot. He did not need to have the powers of his organs transformed into an ordinary

illuminating apparatus on his body like a deep sea fish. All this was solved by the externally kindled flame, the tool of light and warmth. His hand did not need to bear the uncomfortable claws of the carnivera in order to overcome the mammoth outside. The flint knife, the stone tool weapon, in the hand supplanted the claws. In the same way this hand remained supple and easily movable so that as it killed the mammoth outside it could here guide the crayon for painting.

But what was the power that moved this painting hand that slowly formed this mammoth picture here on the cave wall with its trunk, its mane, its four feet, its lurking eye? A memory picture of the living mammoth which it had itself seen months before during the summer.

One of the fundamental characteristics of life has suddenly arisen before us, a characteristic anciently given to life. Remember, it is this characteristic which leads the bird to avoid the net from which it has once painfully freed itself, this power which leads the dog to bark in dreams because he suddenly thinks himself once more upon the chase after the wild animal, this power which led the dog of Ulysses to remember his master when long years had passed. But is it not the same power that leads the radiolaria in the ocean to build today the same little stars that its ancestors first invented millions of

years ago, the same power which leads the migrating birds on the same wandering path which their ancestors have followed for countless generations? Indeed is it not also the same marvelous power which compels the fertilized germ cell in the hen's egg to divide itself according to an absolutely determined system and to divide again and again until a whole cell state arises and which forces the cells of this state to an absolutely determined order of structure and organs, and which finally without any outside assistance, save warmth and air, causes a new living chicken to arise beneath this egg shell? That which has been acquired through the wondrous series of animal generations and bequeathed from the oldest one-celled animals down to the vertebrates and finally to the type of the bird is the power to force the cells of the birds' egg to complete their ordered arrangement in the shortest space of time and perfectly automatically. In the same manner certain associations in the mind can cause a whole chain of events which in actual time were experienced through years or decades or even a whole human life to arise in a single moment in the memory. Does not remembrance rest upon inheritance even from the very beginning of the endless process of life upon the earth? Only through this power of remembrance of the cells does this cave being become possible. It appears very

evident his mind's eye, his cell brain, can stil see this mammoth of the previous summer!

If this mind's picture is now strong enough to move the hand so that the mammoth pictur is placed upon the cave wall then this also is bu the same thing as the ancient directing power o the radiolaria which places in every individual particles of silica in a star or cross after th manner prescribed by inheritance. The metho of this mammoth painting is somewhat widened somewhat less personal in expression. It n longer places particles of silica together to form a bodily covering. It grasps a single large piec of silica, the flint, and scratches, while a pro jection of its protoplasmic body, the hand guides this hard foreign piece of mineral t sketch out the mammoth on the cave wall. Th stage of "tools" contrasted to that of the "or gan" expresses itself here clearly enough in th contrast between the knife and the hearth fire the claws of the beast of prey and the illumin ating organs of the deep sea fish which have grown out of their bodies. The tool is a high er, freer stage, but built upon the same ancient double principle of life, remembrance and pow er of arrangement; these have finally given t that memory picture a body once more, an ex terior actual reality.

Blessed winter that gave such progress t life! Even the trifling cooler night of eterna

summer was sufficient to cause the old reptiles to sink down in stupid inaction. Then came the continuously warmed internally heated animal, but during the long hard winter even this, as the marmot fell asleep or wandered away to the south like the migrating bird. This being in the cave remained and watched and in the time when he could no longer hunt mammoths he created art. Do you see the lines that are scratched here in the bone? They are lines of number. Perhaps it is the number of wild animals killed during the last summer, which this being by the hearth fire with the power of his memory has once more reckoned up. Perhaps it is the number of winters which this individual can recall. The first valuation of a year of life was there. First he counted on his fingers that gave him five and ten as the first great notches in the stick. Then that being in his cave went on to works of art, he took up that same stone knife with which he had scratched out the sketch of the mammoth and cut these number signs in the soft bone. It mediated whether summer when one could go upon the hunt always alternated with winter which drove him into the cave, and why beings of his kind like the mammoth always died after a while and others were born again. Summer and winter. Life and death. Pain and Joy. Over these simple contrasts which marked a difference, a distinc-

tion, in the even course of things,—antagonism which as such even the lowest animal perceived his deep thoughts worked for a long time The dim conception of a double principle in the world came to him, the one advancing, the other checking. But simultaneously came the dim preface of a still more comprehensive force behind both, that of eternal necessity, which turned every summer to winter and brought every creature of his kind to death. And suddenly in contrast with these external powers there came a thought to that strange being before the hearth fire, what art thou now between these powers of fate,—What am I? Out of the dark hither life of intuitive consciousness there arose, like a great flame of light in his internal life, the consciousness that would not simply go along in a stream of sensations but places itself in opposition to things. Around is the world with its powers, and here am I. That thinking creature clasped his hands across his burning forehead. Everything rolled darkly around him. I, the poor miserable creature that must die in the morning, I that nourish life that struggle and defend, that have kindled this fire against the winter foe.

So the primitive powers of life struggled in this creature until they formulated creation and death, struggle and love, for the first time on this planet. Now shall all of this, this result

of endless labor suddenly become clear in consciousness, be expressed in space, give solutions and answers why it is thus and not otherwise. The possibility of contemplation of life concerning life is now suddenly attained. Everything is now to be thought.

This being felt itself lonesome, shivering in spite of his hearth fire as though hunted out of a paradise. He felt the whole contrast: outside the world that simply went on without questioning—here a mind, that imagined, questioned, thought—that questioned, why?

But that being did not know that the same primitive elements of life that had created it, were also active in this question and that this question in itself was an unheard of, new conquest of this life, the highest ever attained upon its whole earthly course. Life that had so long built and built now lay hold on the brain. It was as if a deep voice spoke within it; let us remain, consider, contemplate what we have done. Let us lay down calculation concerning ourselves and permit us to begin to take into account this new power. It needed this power, for greater grew the demands. Let us see how we can move along more direct roads than previously. We have blindly sown seeds and permitted the best to arise. Let us look to see if it is not much better to go with firm step towards a goal. With a being that possesses an eye and remem-

brance, a feeling of contrast and that power of ordering, and knowing itself to be the inner master of a portion of the world in which it can contemplate the past and future, and that it comprehends the motive power of this portion as a conscious end and a definite goal * * *

Suddenly the being awoke from his trance. A dull roar sounded from afar through the cave wall. It was the thunder of a colossal avalanche outside. But when the ice fell, spring was coming. And that being crept through the long, long cave entrance until at last on the rough outer wall whose perpendicular precipice would retain no snow he saw a small shaft-like opening.

It was a moonlight night. Dim green light shone over all. Mysteriously in this light and stretching out far and wide even to the horizon were the endless glacier fields of the ice age.

Like a green fog ocean at midnight seen from a high mountain top it lay there. But to look upon it one must ascend above the clouds, for high mountains then lay so deeply buried that only a dark shady tip raised itself into the moonlit plains. There were indeed single glaciers which reached out icy claws thousands of feet thick from Scandinavia down into the Alps covering over the North and Baltic seas and in the western hemisphere three-fourths of North America were covered. In its frightful precipi-

tous front it broke away like a frozen Niagara. It was spring. Melting water murmured through the still night. The water grew into streams at the margin. The Vistula and Odor were once streams of melted water flowing from the ice.

Then there was a sterile moss steppe, green only during a short summer, to which the herds of mammoths came. This being at his cave window knew this, but what he did not know was the solution of this monstrous spectacle. With a dull shudder only he looked up to the moon that swept like a glittering pearl over folds of light green drapery.

A frightful crisis was passing over the planet earth. Because of cosmical relations the cold of the outer space was given mastery for long thousands of years over wide extents of this planet. A Noah's flood of ice pushed over half the earth. The mountains poured forth ice as the volcanoes pour forth lava. For a long while it was fought back. Perhaps in the primeval days there were a few little forerunners. At last, however, it came in full power as the great ice age raged forth as if the old friendship of the sun to the earth had died out and the icy power of the great world space had sunk down upon it.

With water and with land, with night and with light, life had fought and conquered. To

it had ever been given the victory. Each ne
task had only hardened it and increased i
strength. From the deep sea to the high mou
tain tip it had ruled this planet for many mi
lions of years. It had conquered the earth, no
it must battle with Cosmos. The ice dragon o
the chilling world space crept upon its hear
Ah! look once at the moon there above. It
not for nothing that it shines so shudderingl
silver clear above the ice field. It has alread
been conquered by this cold, it lies already ice
and devastated. What then will happen to tha
delicate life, that foam like skin that itse
quivers like a green moon dust over the eart
when it is set against the world space in whic
all the stars dance like dust particles in the su
light, and when that space shall throw its ic
breath from all sides upon this globe and cov
it and its life, with a hard crystal frost?

To be sure life possesses an ancient power
protect itself against the cold. It has a sort o
marmot faculty of sleeping so long as it is col
This gift it had often used. The bacillus, th
lowest of unicellular creatures, possesses th
power in the highest degree. While in its slee
ing spore condition it can undergo at least th
full cold of outer space—two hundred degree
Slowly the cold reaches from above. Life un
doubtedly develops only to a high degree on
warm star. It does not need to cultivate th

peculiarity of the bacillus. The oak always goes through our winter cold, a frog can be frozen up in a block of ice without dying. A marmot develops no further in spite of its winter sleep. When, however, the earth sinks more and more into the ice of what use shall even this gift be in the end. First the higher forms of life will disappear, the higher organisms will transform themselves again by adjustment into the lower ones, the artificial cell states will finally be dissolved once more into loose swarms of bacteria. The butterfly pines away again to the primitive insect and becomes a glacier fly such as today inhabits the Alpine ice fields and the eternal glaciers of the South polar land. Soon there would remain only red patches* of small algae hanging on the edges of the ice and at last even the toughest bacteria would sink into eternal spore sleep. So the earth would lose its life at last in the icy world space. Perhaps it would be sown on some other warmer star. Upon the earth itself it might never awake.

But this time it did not proceed so far, these glaciers did not cover the earth. They only drove the life into the Southern Zones pressing the temperate zones together and gradually narrowing a great portion of the field of life. The melted water ran. This ice must some day be

*The appearance known as red snow is due to the presence of an alga of the class Chlorophyceae.—Trans.

melted back. Already it seemed to stand at a sharp line as if held back by a mysterious finger saying to it "thus far shalt thou go and no further." At this mark the life destroying cosmical power ended and the favorable powers once more won a place. Baldur, the sun god, once more conquered the ice giant, the giant of the world space. But is not the earth finally doomed? Is it not written in the stars that this catastrophe will come again in a hundred thousand or a million years perhaps, and come with the pitiless inevitability of all great cosmic events and then after so many times will not the ice dragon eat its death meal of life?

Life in struggle with Cosmos—how shall it end?

The answer is written above. That being whose form lies there in that dark shadow cliff in the reddish illuminated cave entrance is man. In that moment when life was threatened by Cosmic powers which lay beyond the earth, it created out of its marrow a living being, which for the first time could look beyond this earth into the cosmos. It was that being standing with his stone knife before his hearth flame who marked the great turning point: the turning point which indicated the change from adjustment to external things to the domination over these things in the sense of an improvement for a definite purpose.

Through all the years that this earth had known life, that life had been building in dim anticipation for this being, its earthly masterpiece. It had experimented and experimented through an endless chain of animal forms further and further toward it. Piece after piece like a costly jewel arises, ring after ring it has put his body together. Then just as the forerunners of the change of climate came and just as an approaching cosmical struggle appeared on the distant horizon it succeeded at last in its final cast. And now when the glaciers swept down like fearful talons and when all the long ago created saurians had gone—then arose this being, this man, with his first fire test. He pushed out to the very foot of the glacier, struck the red flames from the flint and did not sink down in spore or marmot sleep. He watched by the side of this flame, he reckoned, he painted, he thought. When the glacier crept back it had hardened him into the first race. A new day of life had opened. This new champion, who triumphed over the ice age because he had won the warming flame like a domestic animal, was the new twig planted at the right hour in which life once more blossomed forth in boundless capacity, compared with which all the past was but the idyll of a cocoa palm on a tiny coral island.

My mind returns to this natural cave sought

by the man of the ice age in the chalk cliff and I compare it with the tunnel, which man as I know him drives through the granite base of a great mountain, a tunnel which he uses to bind together unhindered his net of commerce around the whole globe. On the mountain there still lies eternal ice, a remnant of the ice age which lowering degrees of temperature could bring further down upon the plain. But in the tunnel we strike upon a glowing blast of hot air. Boiling water springs out of the stone. The deeper you go into the earth the greater is the glow. Man has already begun to send down his tunnel structure building perpendicularly into the depths. He drives shafts into the earth that are still very small, but even in the thin upper strata they have given him that wonderful heating material, coal—, primitive life, the remnants of a petrified forest which still serve to protect later generations against the threatening cold of outer space. Certainly it is true that the coal beds would help but little against an icing over of the whole earth surface. But what if the miner should bring forth the warmth of the earth itself which today only serves to burn out the lungs of the mine laborers? What if man by means of his skill should be able to place the depths of this planet against its outer surface, the inner warmth of the earth against the cold of the world space? The savage of the ice age

fled in ignorant terror before the lightning. We travel with its aid, thoughtless, through the streets of our great cities and laugh when at the stopping of the electric car the blue sparks fly. Just so the man of Pompeii and Martinique fled in deadly horror before the fiery blasts of the volcano. May not the volcano become some time our stove, our trusty hearth fire which we will control as man now controls the electric car?

Then I think once more of life as it wanders in the bottom of the deep sea, as it rises out of the water, as it climbs upon the mountain and into the air. Upon the highest mountain cliff it hangs as a mere speck where a fungus and alga* cling together in close community with brotherly co-operation and are thus able to resist the wild elements, but higher yet than this cliff swings the bird of prey, and over him yet rises the balloon containing men with their scientific instruments. And now this conquest has proceeded down to the deep sea. Equipped with apparatus to meet the increasing pressure the existing deep sea animals of the ocean are able to meet the altered conditions under the pressure of nine hundred atmospheres. The

*The author refers here to lichens which are made up of a fungus associated with an alga. This is spoken of in the text as a relation comparable to "brotherly co-operation." Other authors characterize it as an example of slavery, the algal cells being in a condition of bondage to the fungus, the latter deriving all the benefits arising from the association.—Trans.

cocoanut travels from coral island to coral ii
land across the ocean without the salt wave di
stroying its life. The planet and sun mov
only as single islands in the air ocean.

My glance clings once more modestly an
doubtingly to the old flint knife. With this litt
knife magnified to giant size you can conqu
heaven and earth, you dreamer of life, man. Y
the most marvelous of all is that I can drea
over all this. Why then does my mind fl
through the air ocean and bore deep into th
loins of the earth. All our technique is sti
but an improved flint knife. Our mind a
ready grasps the sum. Out of the primitiv
mental life, however, this flint knife wa
once born. Let us anticipate what tools H
may yet set between himself and his dreams c
the stars.

Loud rushes the melting water and the hig
wall quakes and quakes. White fog rises u
and gradually covers the green glacier plain an
shuts out the moon. Now something run
through the fog, like a rosy light. Mornin
dawns. But its rosy clouds bloom over a meas
ureless empty plain. Sand, naked, yellow san
and on to the horizon. It is the desert befor
which life has ever hesitated. The circling san
is whirled about by the morning wind. It i
not alone where the ice has gone that these des
erts exist. They have their greatest extent i

the hottest portions of the earth. They have always been the deadly enemies of life. So long as life has sought to transform this earth into a beautiful kingdom of Paradise, from the Alpine meadow to the coral abyss, so long have these deserts stood behind it as a warning of death and horror and of the eternal end. The desert where the last drop of water dries up. The waterless planet. Wherever this appears life has always lost the game and this long before the ice came. Sand and naked pieces of rock upon which the sun beats down mercilessly. In the mid-day glow the heat rises on the naked rock to 122° Fahrenheit. No tree, no bushes are able to exist. It is as if the planet had suddenly drawn nearer to the sun, and that blessed star for whose return we hoped, that it might conquer the ice age now gives rise to the typhoon, to the god of death that burns out life. In a monstrous fire the red ball of the sun rises up here. Is it also a part of the cosmic relation that the sun which at the ice age perhaps drew away from us should now return again? The globe has hardened from a glowing mass.* Shall it return once more to the glowing condition? Shall life that discovered its own hearth flame in the ice go out in the fire?

*The position taken by the author that the earth was once a glowing ball is now contradicted by good authority. The planetismal theory of the origin of the earth seems to be displacing the nebular hypothesis.—Trans.

But what is this that suddenly appears in the first glow of the sun? A glittering silver canal travels across the desert. Palms wave upon its edges. It is man who, with his tools, has directed this canal from ocean to ocean. His bright colored ships pass through it and as the eye wanders there arises behind it a wondrous picture. Columned halls, pyramids, giant stone pictures made by human hands? They are built upon the very edge of the desert. Ah, then man has gone into the desert. What no animal beneath him, and no plant has dared he has done, even in far distant ages. It was just the desert which enlarged and developed to a higher degree mentally, that wild mammoth hunter. In its mysterious loneliness before which life has bowed down in fear through so many millions of years he struck his tent. Drinking out of his leathern bottle as he had once done in his cave in the ice age he thought.

But in his thoughts here, there arose something incomparably more powerful than in the ice cave. His view no longer shut in behind a low cave wall on which the red flames danced, went up and up into the still night and above him there burned in cloudless clearness the stars. The measureless majesty of the cosmos beyond the earth with its silver world dust lay before him.

What a distance from the noctiluca which it-

self formed an illuminated living point in the world ocean up to this first glance of the desert folk turning human eyes toward the star ocean! In this moment the dark wall between life and cosmos really fell—the globe itself recognized its neighbors as once the first loving male animal recognized its wife.

This man who had learned to kill the mammoth and to count his ten fingers began to look upon the quiet changes of the stars and understand them. It was in the desert that astronomy was born. From the stars the glance went on higher and farther out. The cave man had questioned: what am I in the presence of summer and winter, of birth and death? Out of the desert has come the first great religious philosophy. It was amid nomadic living desert peoples that our great philosophical ideas first arose in the sacred stillness beneath the shining starry heavens—the ideas with which man in the highest sense has now conquered heaven and earth. Cosmical views (weltanshaung)! Do you understand what this signifies in the triumph of life, to which the earth has become too narrow, so that it has stormed the cosmic power of which it has become conscious and has learned to formulate direct purposes and begun to master nature by means of natural forces. This new spirit of life already looks out over the world and this

world includes within itself fixed stars and milk
ways billions of miles distant.

What are the stars? What is the whole
What is the nature god? When man so ques
tioned then life played its last part. Surround
ed by danger, between the dragon of the ice ag
and the typhoon of the desert god, there wa
born of its environment, a being that for th
first time conquered cosmic adaptation. I
struggled on to higher ideas until it laid it
hand upon this whole earth and solved, an
triumphed over all those technical problems be
fore which life had stood despairing through
millions of years but which to it were onl
child's play. Man, the highest adjustment t
the earth, master of his planet through his tech
nique—and this man now wandering in though
through the whole star system and formulating
its laws—shall not life with this being ye
triumph through countless eons, over glowing
deserts, and ice ages, chilling suns and dissolv
ing planets if in the incomprehensible length o
time, to thought and to desire is added the thir
thing, deed?

Now the kiss of the rising sun touches th
stone statue, that rises high over the desert. I
is the old statue of Memnon which, as the fabl
tells us, sang when the sun touched it. Just s
the triumph of life is only a tone of a low
chord upon which the sun has played through

eons. The sun we do not see. It lies deep below our horizon. But we hear how this tone rises, grows more and more beautiful, how it finds higher melodies until it seems that the instrument would break. The radiolaria in its ocean depth is one such tone. We are another. Our desires are yet another. One tone is thrown out by the first cell, another sounds around the earth. Another trembles out into the star world. It must yet be a marvelous sun. * * *

KU-146-688